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DICTIONARY OF EXPLOSIVES, AMMUNITION AND WEAPONS

(GERMAN SECTION)

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GERMAN EXPLOSIVES, PROPELLANTS, AMMUNITION AND RELATED ITEMS

Foreword.

In both WWI and WWII the Germans suffered great shortages of TNT, NG, etc and had to resort to substitute explosives (called Ersatzsprengstoffe) which in many cases were inferior and more expensive than those used by the Allies. The same may be said about the propellants.

The development of German military explosives and propellants may be subdivided into the following:

A. Period Before WWI. Black powder was used as a propellant and as an explosive up to the eighties when it was replaced for a short period by brown powder and finally in the nineties by smokeless propellants invented by Duttenhofer. A single-base tubular propellant was adopted in 1897, under the name of RP'97 (Röhrenpulver 1897) and a double-base tubular propellant (Nitroglycerinpulver) called RP'07 was adopted in 1907. In addition to these the Germans made a flake propellant (Blättchenpulver) and a dish- or cube propellant (Würfelpulver). As a filler for projectiles the black powder was replaced in 1888 for a short period by picric acid (P A) and then in 1902 by TNT.

B. Period of WWI. Due to the shortage of NG the Germans were forced either to use single-base propellants or to substitute the NG in double-base propellants by some other HE, such as TNT or DNT. During the latter part of WWI, when a shortage of cotton developed due to the Allied blockade, the Germans resorted to the use of wood pulp in the form of crepe paper for nitration to NC and also to the use of compositions not containing any NC or NG (See Ammonpulver)

As high-explosives for filling projectiles the Germans used in addition to TNT DNB, TNAns and mixtures of these with Am nitrate. In the later part of the war, when these aromatic nitrocompounds became scarce, they began using HNDPhA, TNX, HNDPh, TNN, HNDPh sulfide and their mixtures with Am nitrate, Pb nitrate and K chlorate. Commercial blasting explosives, such as Donarit and Westphalit, and other more sensitive explosives were used for projectiles which were subjected to little or no setback, such as trench mortar shells, grenades and bombs. The Germans also started to incorporate Al powder in underwater explosives. All of these substitutes were fairly powerful and superior to the mixtures which they were forced to use during the later part of WWII.

C. Period Before WWII. Beginning in the middle 1930's the Germans foresaw a war and began the development of explosives which could be used to replace those prepd by the nitration of aromatic hydrocarbons (derived from coal tar), of which it was patent there would be a shortage. The most important of these explosives were Hexogen (Cyclonite or RDX) and Pentrit (Pentaerythritoltetranitrate or PETN). Both of these explosives were derived from aliphatic compounds of which no shortage was expected during a war. In addition, these explosives were much more powerful than TNT, PA, or even tetryl, but they were too sensitive to be used alone as bursting charges in shells. This difficulty was overcome, however, by coating the particles of these explosives with about 10% of Montan wax applied in the molten condition. Such explosive mixtures could be safely press-loaded into projectiles, such as 20mm to 30mm shells or loaded into boosters or various shell. These mixtures could not be cast because the m p's of RDX and PETN are too high to permit them to be melted with low pressure steam. When it was desired to load shells by casting, the Germans mixed RDX or PETN with about equal parts of low-melting explosives such as DNB or TNT.

In addition to these superior explosives the Germans began the development of some rather inferior explosives before WWII. These were called Ersatzsprengstoffe (qv) (Substitute explosives).

As to propellants, about 5 years before WWII, the Germans started to develop double-base propellants which contained DEGDN (in lieu of NG) with or without NGu. These were superior to NG powders because being "cooler" they caused much less erosion of the gun barrels. The development of these propellants was done under the direction of General Uro Gallwitz (See Propellants).

D. Period of WWII. At the beginning of the war the Germans did not experience a shortage of aromatic nitrocompounds and were able to use the following explosives for loading shells: TNT, DNB, P A, tetryl, HNDPhA, some alone and others in admixtures with other explosives. For underwater explosives, the Germans incorporated about 15% of powdered Al in the high explosives, as had already been done by them in WWI (See also under Aluminized Explosives, under A).

Of the explosives mentioned above, all except DNB may be considered as good military explosives. DNB is not as good because it is less powerful and more toxic than TNT. It was used, however, to stretch the supply of TNT in amatol and ammonal-types of explosive mixtures. The comparatively low m p of DNB (ca 90°) permitted its use with loading mixtures containing Am nitrate, Al, etc. Such mixtures did not exude even at tropical temperatures.

As mentioned above, the Germans before WWII, developed two of the most powerful explosives, RDX and PETN. When these explosives became available on an industrial scale they started to replace the aromatic nitrocompounds as bursting charges for various projectiles, as boosters and as base charges for detonators. When Al powder was incorporated in mixtures of RDX and PETN with other substances the resulting explosives were the most powerful and brisant underwater explosives. It was by the use of these that the Germans sank many American and British ships.

The enormous demand for explosives and the shortage of raw materials created a situation, about 1943, which made it necessary to use substitutes inferior to TNT, thus lowering the efficiency of their ammunition. These mixtures are listed, and some of them described, under Ersatzsprengstoffe (q v).

The Germans used single-base propellants in small arms and in some smaller guns, while double-base propellants in which part or all the NG was replaced by DEGDN (or sometimes TEGDN), with or without NGu, were used in 37mm or larger caliber cannon. A propellant of tubular granulation was used for guns, while either flake or disk type was used in howitzers (See Propellants).

Following are some figures for the monthly production, in metric tons of the principal high explosives for the years 1943 and 1944:

Explosives	As of June 1943 (Produced)	As of June 1944 (Scheduled)
TNT	16,600	21,000
P A	280	400
DNB	1,380	5,000
Tetryl	16	30
HNDPhA	650	950
RDX	2,470	7,000
PETN	820	1,400

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c) Dr M. M. Kostevitch, Buenos Aires, Argentina
d) Wm. H. Rinkenbach, Allentown, Pennsylvania
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Abbreviations for Ordnance Terms

American and British abbreviations are given under individual items, whereas German abbreviations are assembled in a separate section at the end of this dictionary.

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Due to the shortage of funds for this dictionary, every effort was made to keep the typing and printing costs as low as possible. For this reason the lower cost varitypping (outside contract) was used instead of the better but more expensive linotyping

Abbreviations Used in References

AEF	Allied Expeditionary Force
Anon	Anonymous
Barnett	Barnett, Explosives, Van Nostrand, N Y (1919)
BIOS	British Intelligence Objectives Sub-Committee
Br	British
CIOS	Combined Intelligence Objectives Sub-Committee
Colver	Colver, High Explosives, Van Nostrand, N Y (1918)
Davis	Davis Chemistry of Powder and Explosives, Wiley, N Y (1943)
D C	District of Columbia
DRP	Deutsches Reichs Patent(German Patent)
FIAT	Field Intelligence Agency, Technical
FM	Field Manual
Ger	German
Govt	Government
Gt Br	Great Britain
HMSO	His Majesty's Stationery Office
Marshall	Marshall, Explosives, Churchill, London, v 1 & 2 (1917), v 3 (1932)
Md	Maryland
Mém Artil Fr	Mémorial de l'Artillerie Française
Mém poud	Mémorial des poudres
Nav Ord	Naval Ordnance
NDRC	National Defense Research Council
N J	New Jersey
N Y	New York
OSRD	Office of Scientific Research and Development
Pa	Pennsylvania
Pat or P	Patent
PB	Publication Board (of the U S Office of Technical Services)
Pic Arsn	Picatinny Arsenal, Dover, N J
Rept	Report
SS	Zeitschrift für das gesamte Schiess- und Sprengstoffwesen
TM	Technical Manual
u	und (Ger for "and")
USP	United States Patent
v	volume
v	von

Remarks

This compilation has been made with the object of providing a ready reference to the subject matter covered by means of an alphabetical arrangement. In general, only sufficient information is furnished for understanding of the principles, meaning of terms, process, mechanical layout etc. Numerous references to original sources are provided for those seeking more detailed information. Classified information has been carefully excluded. However, a few classified references have been given to permit further study by those with authorized access to such sources. No attempt has been made to include all data and information available to the Ordnance Corps.

It should be noted that the use of the period with abbreviations, in the tables and at the end of sentences was, in general, omitted where this could be done without causing any difficulty to the reader. However, a period was used at the end of each dictionary item to indicate the conclusion of the item.

Some last minute changes and insertions were made by Dr Fedoroff and not edited. For faulty punctuation, poor English or irregular arrangements, he assumes the responsibility and hopes that the sense of the text is clear everywhere.

It is hoped that the General and Analytical sections of this project, "A Dictionary of Explosives, Ammunition and Weapons", will be linotyped and present a better appearance than was possible to date.

NOTE

The General and Analytical Sections referred to in the body of this Section have not yet been published. It is expected that preparation of the General and Analytical Sections will be started early in 1958 with a publication target date sometime in 1960. Data under each letter of the alphabet will constitute a separate report.

The General Section will cover American and British explosives, ordnance terms and a short resume of American and British ammunition and weapons.

The Foreign Section will include explosives, ammunition and weapons of countries other than U S and British, i e, German (this section), French, Italian, Japanese, Belgian, Czech, Spanish, Swedish, Swiss and Russian. Only the Russian Section has been published to date as Picatinny Arsenal Technical Report No. 2145, February 1955. The Russian Section is classified Confidential.

LIST OF GERMAN EXPLOSIVES, AMMUNITION AND RELATED ITEMS

"121" (Firing Composition). See Firing Composition 121.

"A" (Raketen). "A" (Rockets). Beginning about 1933, the Germans started to experiment with military rockets. The first model was the A-1 which weighed about 330 lbs and was 5' 7" long and 1 ft in diameter; it was unsuccessful. The next rocket, the A-2, which appeared in 1934, was an improved A-1 and when fired it reached an altitude of 6000 feet. In 1938, at Peenemunde, the A-3 was developed. This was the predecessor of the A-4, developed in December 1942 and now commonly known as the V-2. The A-3 rocket weighed 1,650 lbs and was 25 ft long and 2½ ft in diameter. The A-4 rocket is briefly described under V-2. The next A rockets that were developed at Peenemünde: the A-5, A-6, A-7, A-8, A-9 and A-10, were purely experimental. Among these, the A-9 and A-10 were intended for bombardment of the USA. The A-9 was intended to be carried aloft by the A-1 during the first phase of the trans-Atlantic trip.
Reference: F. Ross Jr, Guided Missiles, Rockets and Torpedoes, Lothrop & Co., NY (1951), pp 22-34.

A-2. Same as V-2.

A-4 (Rocket). Same as V-2 (Rocket).
[See also W. Dornberger, V-2, Viking, NY (1954)].

"A6" (Fuseheads) were low tension fuseheads developed at Troisdorf Fabrik as substitutes for the "G 3" fuseheads after it became difficult to obtain cerium - magnesium alloy (called Mischmetall), one of the essential ingredients of G 3.

The A6 fuseheads were manufd by dipping the tip of a bridge wire successively into the following compositions:

a) First dip composition consisted of dry Pb picrate 90g and silicon (particle size 20 to 40 microns) 10g, suspended in about 75 ml of a 2% soln of NC in amyl or butyl acetate. After the coating was dry, the bead on the bridge wire was dipped into the

b) Second dip composition which consisted of dry Pb picrate 50g, Pb chromate 35g and silicon (size 20 to 40 microns) 15g, suspended in about 75 ml of 5% soln of NC in amyl, or butyl acetate. The dried bead was dipped into the

c) Third dip composition which was a lacquer consisting of a 15% soln of NC in 75/25 - butyl acetate/alcohol, to which was added 20% Sipalin AOM (methyl-cyclohexyl ester of adipic acid) calculated on the dry weight of the NC. Then the dried bead was dipped into the

d) Fourth dip composition which consisted of NC lacquer as in (c) to which was added 0.8g of Sudan Brown (0.8g per 10 l of lacquer).

Further operations are the same as described under Fusehead Manufacture.
Reference: R. Ashcroft et al, BIOS Final Rept No 833, Item No 2 (1946), p A-3/35.

A-9/A-10. Long range guided missile designed to have a range of 5,000 km is briefly described in TM 9-1985-2 (1953), p 233.

Abbreviations for Ordnance Terms. See Ordnance Terms and Abbreviations in this section.

Abfallsäure or Abgangssäure. See Waste (or Spent) Acids.

Abraschit 2. Same as Filler No 57.

Absolute Method of Measurement Based on Impulse (Absolut Messverfahren auf Grund des Kraftstoss). A. Schmidt developed a method which permitted calculation of the mechanical work produced by the detonation of an explosive. It is described briefly by A. Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 116.

Acetylen (Acetylene). See general section and the following references:
1) W. Reppe, Advances in Acetylene Chemistry, PB Rept 1112 (about 1946)
2) W. Reppe, Synthesis of Intermediates for Polyamides on Acetylene Basis, PB Rept 25,553 (about 1946).

Active Sheath (Aktive Mantelpatrone). A type of sheath containing NG or NGc (nitroglycol) together with inert ingredients was used by the Germans for some permissible explosives, such as Wetter-Wasagit, etc. One of the earlier active sheaths consisted of NG 15, rock salt 35 and Na bicarbonate 50% but this was later changed to NG (with or without nitroglycol) 12, rock salt 33 and Na bicarbonate 55%. The composition of some other active sheaths were:

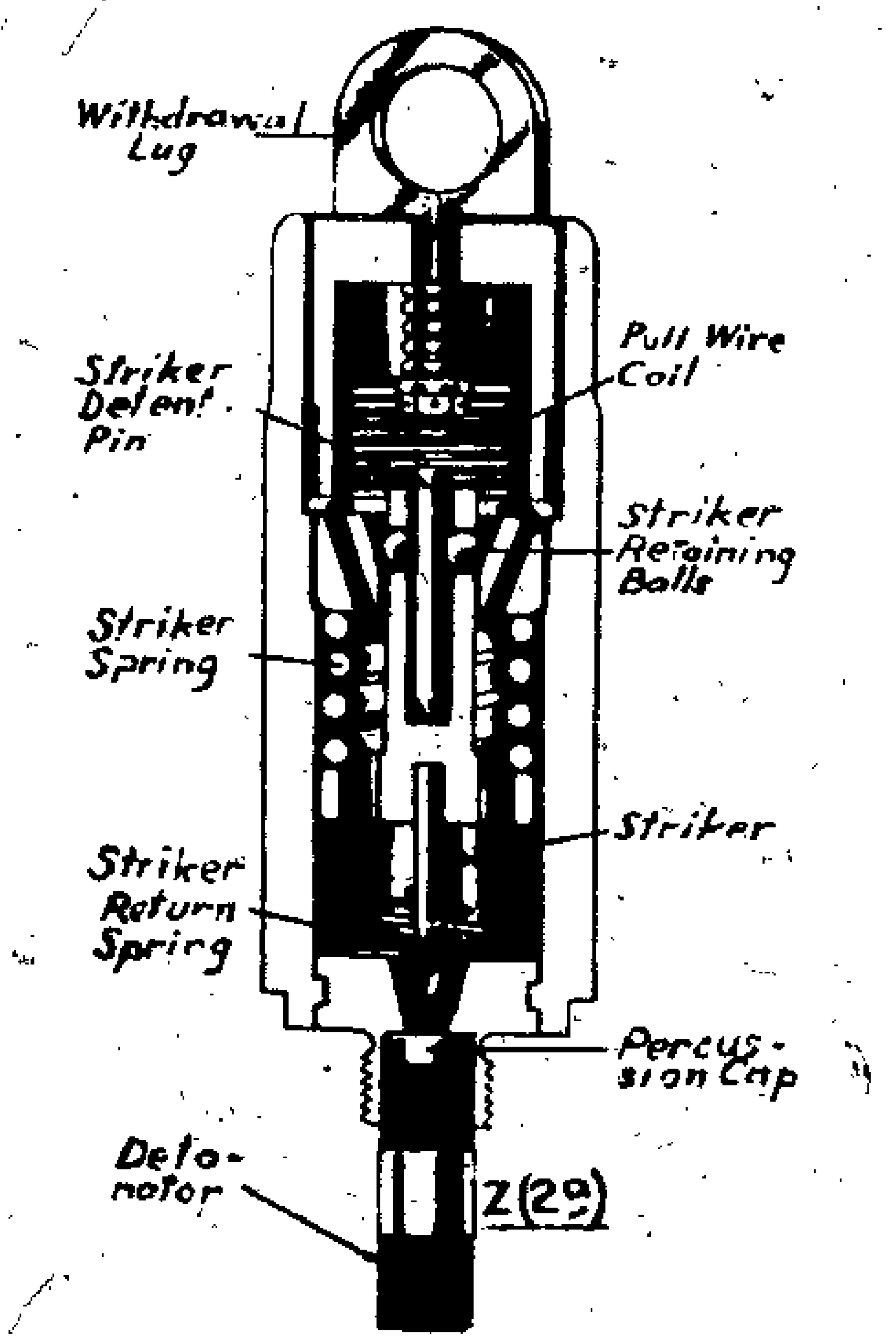
Sheath	NG	NGc	NaCl	Na bicarbonate	Kieselguhr
M_1	10.0	-	35.0	55.0	-
M_3	12.0	-	68.0	20.0	-
M_4	11.0	1.0	87.0	-	1.0
M_5	10.0	-	88.0	-	2.0

The sheathing operation was carried out automatically at the Sythen plant of WASAG, on a modified Niepmann cartridging machine, permitting cartridges weighing 70 grams to be sheathed with 55 grams of active sheathing material.
Note: According to Stettbacher (Ref 3) a sheath (Mantelpatrone) 25 mm in diameter and 3.5 mm thick, consisting of Na bicarbonate 82 - 85 with NG 18 - 15%, reduces the temperature of the gases of detonation from 2000° (for an unsheathed explosive) to 400°C.
Note: According to T. Urbański, Przemysl Chemiczny 4, 487, (1948), the active layer (sheath) was made in the form of a tube slightly larger than the cartridge of the regular charge. The cartridge was then inserted into the tube. When the cartridge was exploded, the combustible protective layer (sheath) was dispersed and vaporized, thus forming a "cloud of salt" which prevented the ignition of firedamp or coal dust which might be caused by the charge alone.
(See also "Sheathed Explosives" in the general section).
References:
1) O. W. Stickland, PB Rept No 925 (1945)
2) R. Ashcroft, PB Rept No 63,877 (1946), pp A-1/8 and A-1/11
3) A. Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 92.

Aerial Burst Fuzes are devices designed to function a bomb while still in flight. Following German fuzes are briefly described in TM 9-1985-2 (1953), pp 132, 168, 171 174-8:

1) (41) Mechanical Clockwork Fuze was used in SD 2A Butterfly bomb (pp 132-3)

2) (29) Mechanical Aerial Burst Fuze, used in the LC 10f single unit parachute flare, consisted of a bakelite housing containing a closing cap, withdrawal lug, safety spring, striker pellet guide, striker pellet, striker detent pin, firing spring, two ball detents, and a striker return spring. The withdrawal lug and the closing cap were retained by a cord which was attached to the flare parachute. As the flare descended the safety spring was extended until it was tensioned sufficiently to withdraw the striker detent pin. The ball detents were then free to move inward, and the striker pellet was forced by the firing spring to carry the striker into the percussion cap. At the end of its travel, the striker pellet compressed the striker return spring. The flash from the cap ignited the delay element and, after the delay, the detonator initiated the main charge of the bomb (pp 168-9)



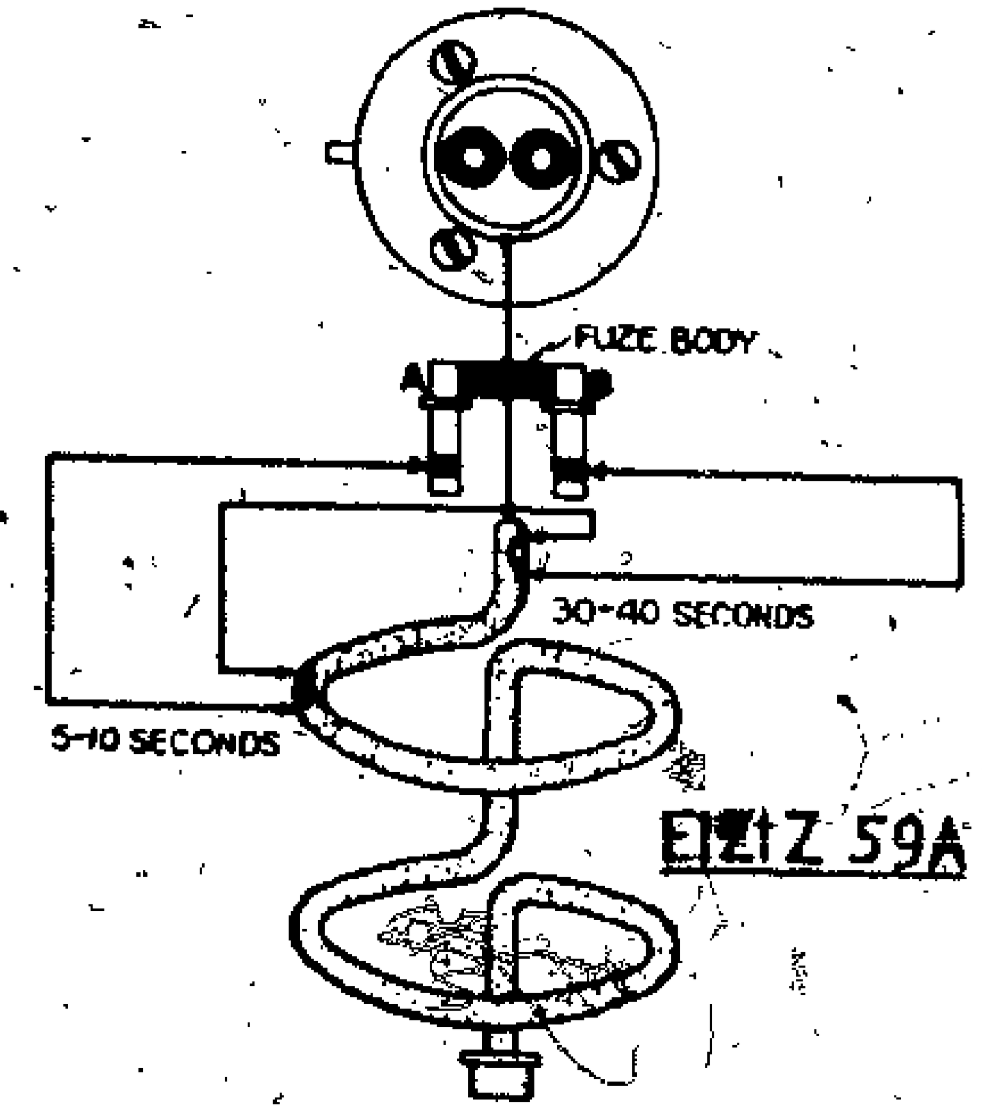
3) Pyrotechnic Aerial Burst Fuzes (49)AII and (49)BII were used in some rocket bombs, such as PC 500RS and PC 1000RS (p 169)

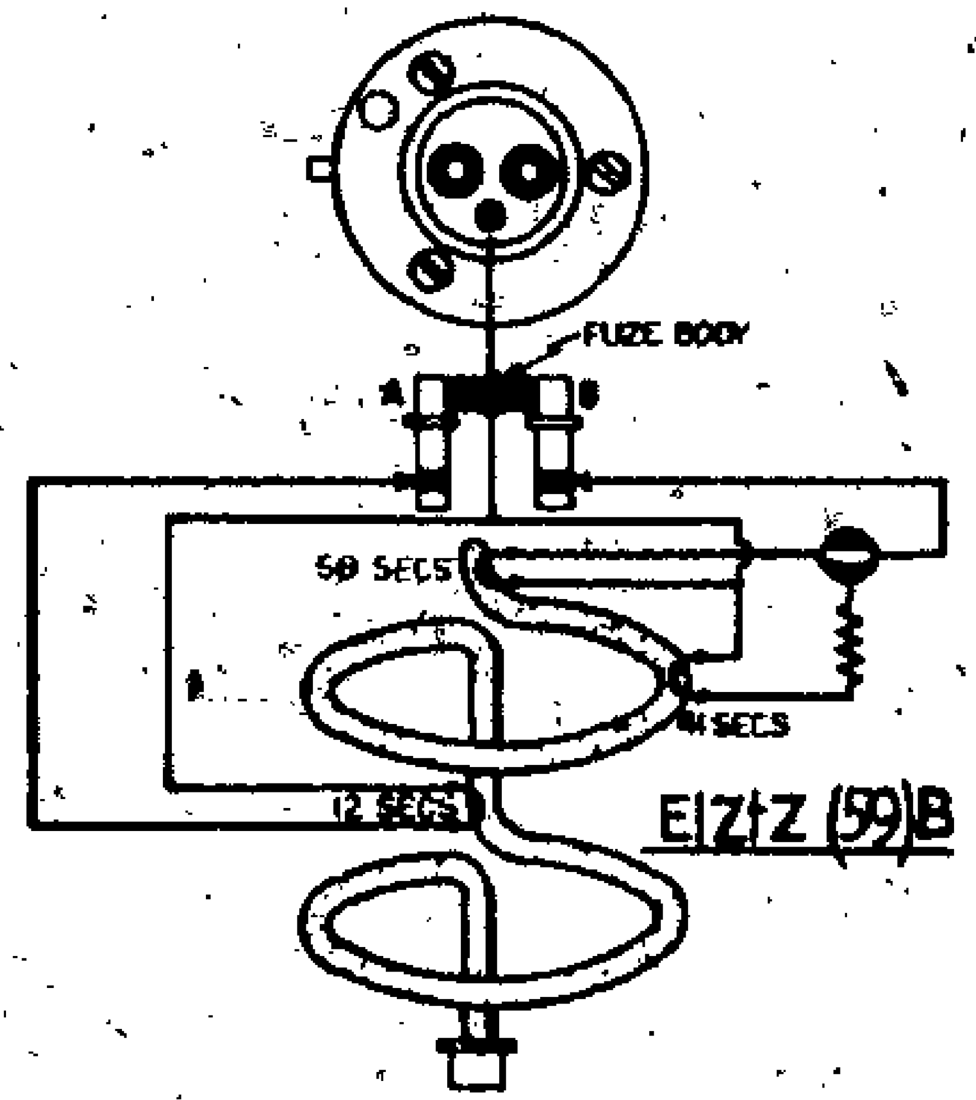
4) (59) Mechanical Aerial Burst Fuze was used in parachute flares and photoflash bombs (pp 171-2)

5) 59A and (59)A Electrical Aerial Burst Fuzes (ElZtZ) used in some antipersonnel and incendiary containers, consisted of two igniter bridges connected directly to the two plungers without any intervening condensers or resistances. The bridges were thus fired as soon as the bomb or flare left the aircraft, initiating pyrotechnic delay trains which provided the aerial burst functioning. The shorter delay was fired from the A plunger and the longer delay from the B plunger. If both plungers were charged, the short delay functioned and if only B was charged, the longer delay functioned. The inner construction of both fuzes was the same, but the (59)A was twice as long as the 59A (p 172)

6) (59)B Electric Aerial Burst Fuze (ElZtZ) used in SC 250 bomb and in some parachute flares, differed from the previous fuze by having three igniters instead of the conventional two. The igniter under the A plunger was in such a position as to give a 12-second delay. The other two igniters were under the B plunger and gave 41 and 58 second delays respectively. If the short delay was required, both plungers were charged. If a longer delay was necessary, only the B plunger was charged (pp 172-3)

7) 69CII, 69D and 69E Electrical Aerial Burst Fuzes (Pyrotechnic Delay), used in various bombs and containers, were cylindrical in shape and made of aluminum. On release from the plane, the igniter bridge fired igniting the loose black powder. This in turn ignited the pyrotechnic delay mixture (no composition was given). On expiration of burning of the delay, the flash composition and the black powder pellet were





ignited, etc (pp 174-5)

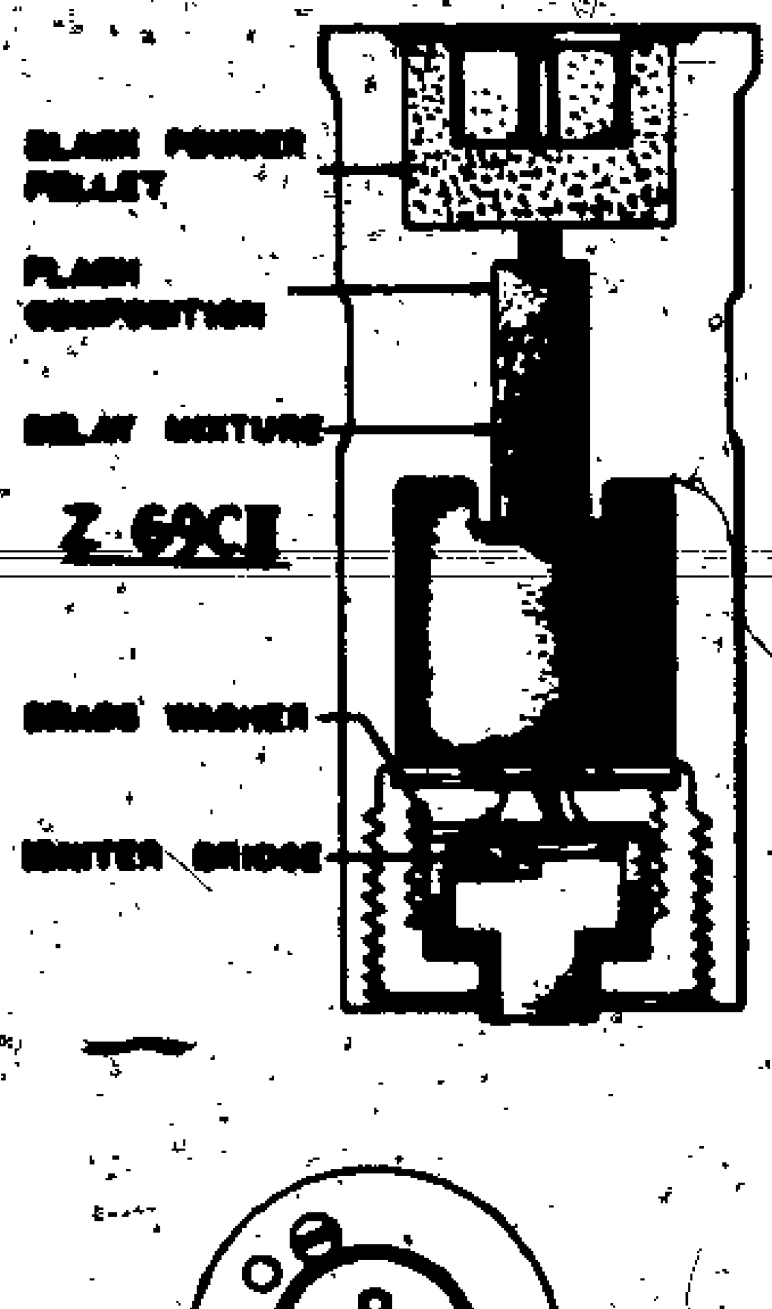
8) 79, (79) and (79)A Electrical Aerial Burst Fuzes (Pyrotechnic Delay) used in parachute flares and photoflash bombs, resembled in appearance and action the 59 fuzes (pp 174-5)

9) (89), (89)B, (89)C and (89)D Clockwork Aerial Burst Fuzes are described on pp 175-7

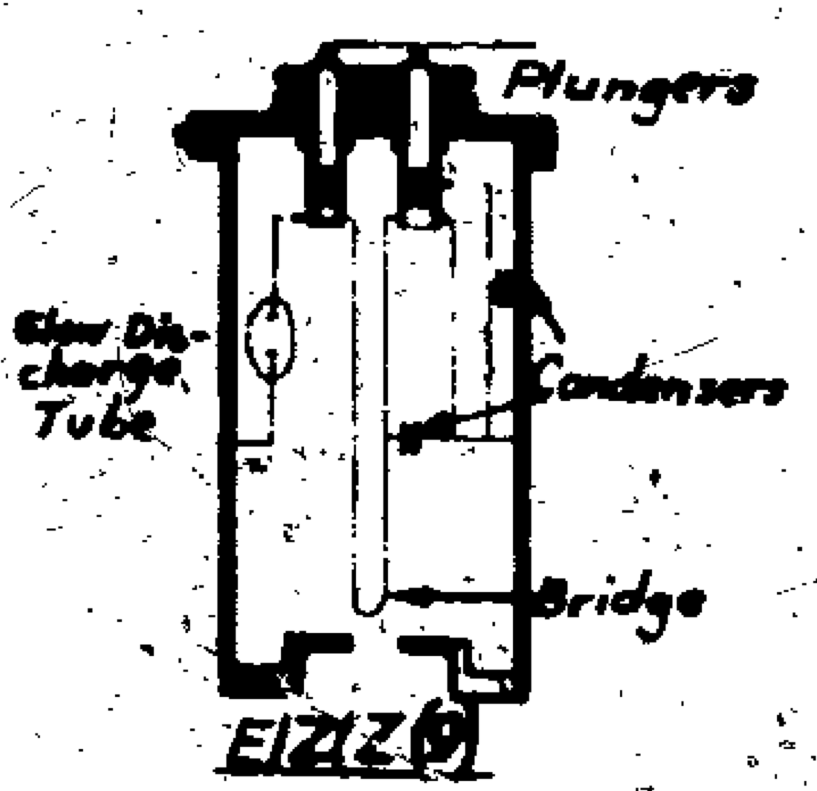
The following aerial burst fuzes are described in TM E9-1983 (1942), File Nos: 2314.9, 2324.91, 2324.92, 2324.93, 2342.9:
(59) Mechanical Aerial Burst Fuze
(9) Electrical Aerial Burst Fuze (See below)
(49) Aerial Burst (Special) Fuzes
(59)A Electrical Aerial Burst Short Time Fuze
(89) Clockwork Aerial Burst Short Time Fuze. One of these fuzes is described below

10) (9) and (9)* Electrical Aerial Burst (Short Time) Fuzes, used in some parachute flares and in BIC 50 photoflash bomb, were cylindrical in shape and contained a glow discharge tube, two condensers, a resistance, a

bridge and two charging plungers. The third, smaller plunger, was believed to be used for testing the glow discharge tube. Before dropping the flare, the charge from the plane passed through the plunger into the charging condenser. The charge then slowly leaked through a resistance to the firing condenser. At the same time, a similar charge was built up on one plate of the neon-filled glow-discharge tube. When the charge, which had slowly leaked by and through the igniter bridge, had built up on the other plate of the discharge tube to the striking voltage of the gas, the current surged through the tube and igniter bridge which then ignited the quick-match main which fired the burster charge of the flare or of the photoflash bomb. The function of the glow discharge tube was similar to a condenser.



Z 69CII



EIZIZ(9)

Agesid 2. One of the pre-WWI dynamites: NG 30.0, vegetable jelly 2.0, wood meal 1.0, Am nitrate 36.0, K chloride 31.0%, oxygen balance + 5.0%, Trauzl test 225 cc [Naoúm, Nitroglycerin (1928), p 411].

Akardit (Acardite, or asym-Diphenylurea). Described in the general section. Acardite was used by the Germans in some smokeless propellants. When used in small quantities (say 0.5%) it was as a stabilizer, while in larger quantities (e g 8%), it was used as a moderator of the burning rate and as a flash reducer.

Note: According to PB Rept No 11,544, neither as asym nor a sym DPhU exercises any gelatinizing action on NC, especially if NC is of high nitrogen content.

During WW II, the Germans called asym-DPhU Akardit I, because they developed two other derivatives of urea: Akardit II, $(H_3C)HN.CO.N(C_6H_5)_2$, and Akardit III, $(H_5C_2)HN.CO.N(C_6H_5)_2$. As a stabilizer, Akardit II was better than Akardit III, and the latter was better than Akardit I. For gelatinization of NC Akardit III was better than Akardit II, and II was better than I [See PB Rept No 925 (1945) p 18].

Albit. See Gesteins-Albit.

Aldorfit (Aldorfite). A Favier-type explosive invented in Switzerland and also used in Germany. *For example*: Am nitrate 81, TNT 17 and rye flour 2%; velocity of detonation 4960 m/sec at d 1.17 for charges confined in 50 mm diameter steel tubes.

References:

1) Marshall, 1(1917), p 391 2) Barnett(1919), p195 (See also under Swiss Explosives).

Aliphatic Nitramines of WW II. Out of a great number of aliphatic nitramines examined in Germany during WW II from the point of view of utilizing them as explosives or as plasticizers for NC, Römer mentions that two of them: $(O_2N.O)CH_2N(NO_2)CH_2N(NO_2)CH_2N(NO_2)CH_2(ONO_2)$, m p 135° and $(O_2NO)CH_2N(NO_2)CH_2N(NO_2)CH_2N(NO_2)CH_2N(NO_2)CH_2(ONO_2)$, m p 211°, are of particular interest because they seem to be more powerful than RDX, judged by the Trauzl lead block test. Both nitramines were obtained as by-products in the manufacture of RDX using either the E-Salz or the KA-Salz process. [G.Römer, PBL Rept No 85,160 (1946), p 16].

Note: According to Mr L.Silberman of Picatinny Arsenal, the above compounds are called:

1,7-Dinitroxy-2,4,6-trinitro-2,4,6-triaza heptane and 1,9-Dinitroxy-2,4,6,8-tetranitro-2,4,6,8-tetrazanonane.

The description of these compounds is given in the general section.

Alkalsit (Alcalsite). A type of blasting explosive based on perchlorates, such as Alkalsit I: K chlorate 28, Am nitrate 25, K or Na nitrate 30, nitrobody (such as TNT) 11.5, wood or cereal meal 2.5, resin (such as colophony) 2.5, and hydrocarbon 0.5%).

References:

1) F. Ullmann, Enzyklopädie der technischen Chemie, Urban & Schwarzenberg, Berlin, v 4 (1929), p 788; 2) A. Pérez-Ara, Tratado de Explosivos, Cultural, La Habana (Cuba) (1945) p 218.

Alloy Steels, especially high temperature alloys, such as Böhler alloy, Cromador, Remanit, Sicromal 8, Thermanit and Tenax are described in CIOS Rept File No 29-23 (1946)

Aluminium (Aluminum) is described in the general section. The German electrolytic method of manufacture of Al from bauxite is described in CIOS Rept File No 22-4 (1946)

Aluminized Explosives (Aluminiumhaltige Sprengstoffe). The use of Al explosives was begun about 1900 (in Austria) and such explosives were known as Ammonals. One such explosive was tested in France in 1902 by the Commission des Substances Explosives. According to Lheure it contained: Al 25, Am nitrate 71, charcoal 4%. Another aluminized explosive, called Führer, contained: Al 14, Am nitrate 83 and charcoal 3%.

The role of Al in explosives was not very clear until recently when it was explained by A.Stettbacher of Switzerland (Ref 1) and H.Muraour of France (Ref 2). After it was found that Al is particularly effective when used in underwater explosives, the Germans replaced their underwater explosive of WW I: TNT 60, HNDPhA (hexanitrodiphenylamine 40 by the following mixture: TNT 55.7, HNDPhA 27.9 and Al grit (40-70 mesh) 16.4%. The same idea was followed in Sweden, where Al was used in their Bonit and Novit explosives. Great Britain and the U S A also included Al in underwater explosives, such as Torpex and Tritonal (British UWE). The Italians and Japanese also used Al explosives. According to Stettbacher, another German underwater explosive contained: TNT 61.8, HNDPhA 23.0, Al 15.2%.

Among German aluminized explosives developed before or during WW II may be cited: S-6, S-6 modif, S-19, S-22, S-26, E-4, KMA and S-16. Their compositions are given under Ersatzsprengstoffe (See also Anagon, Berclavit B, and Nitrobaronit).

(For more information see Aluminized Explosives in the general section).

References:

1) A. Stettbacher, Protar 9, 33-45 (1943)

2) H. Muraour, ibid, 62-63 (1943)

3) L.Médard, Mém Art Fr 22, 595-611 (1948), Aluminized Explosives

4) A. Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), p 88-90.

Aluminum-Chloromethyl Mixture. See Methyl Stoff.

Aluminum Mine. See under Landminen and also on p 273 of TM 9-1985-2 (1953).

Amatol (Füllpulver, abbreviated Fp) (Amatol). The composition of most amatols was TNT and ammonium nitrate, but the designation was the reverse of the American amatols. For instance, German 40-60 Amatol or Fp 40-60, corresponded to the American 60/40 Amatol (Am nitrate 60, TNT 40). (See also Filler No 13, - No 14a and - No 88).

There were also German amatols which contained no TNT but some other explosive or explosives. These amatols (No 39, 40 and 41) are described below.

Amatol 39. A mixture developed by Römer (Ref 2) as a bursting charge for the V-1 rockets. It contained DNB 50, Am nitrate 35, RDX 15, and was claimed to be as powerful as Fp 60/40 (TNT 60, Am nitrate 40). Due to the toxicity of DNB, loading of the projectiles was conducted in a special building provided with good ventilation. As it was difficult to cast-load Amatol 39 uniformly (without formation of cavities) in large caliber projectiles, G. Römer (Ref 2) used the so-called "Biscuit" loading method. In this method, a projectile was filled alternately with pieces (pellets) of so-called "biscuit mixture A" (Am nitrate 50, technical Ca nitrate 25, PETN 10 and RDX 15%) and molten Amatol 39 at a temperature of about 80°. The resulting mixture formed no cavities on cooling. Its density at room temperature was 1.58, velocity of detonation 5600 m/sec, Trauzl lead block expansion test 350 cc for a 10 g sample and a crusher test value (Stauchprobe) (compression of a lead block) 17.5 mm.

Notes: a) According to Ref 3, Amatol 39 was developed in 1939 at the Krümmel Fabrik of Dynamit A-G and was used for filling projectiles.

b) One of the Amatols 39 was used in underwater explosive charges.

Amatol 40. This explosive was sometimes used during WW II for filling the war head of V-1 Rockets. It contained DNAns 50, Am nitrate 35 and RDX 15%. It could be cast-loaded like TNT (Ref 3).

(Another composition, also known as Amatol 40, is given under Ersatzsprengstoffe).

Amatol 41. An explosive similar in composition to ammonites: Am nitrate 52, Ca nitrate (tech) 6, PH-Salz 30, RDX 10, montan wax 2%; density of fragments 40 m (TNT 40 m); used in bombs (Ref 3).

Note: According to Ref 1, Kast, as early as 1915, proposed the mixture of Am nitrate 40 and TNT 60% for cast-loading German projectiles. The same mixture was used later by the British under the name of 40/60 Amatol. According to Urbański (Ref 3) an Amatol of WW II contained TNT 50, RDX 5-10 and Am nitrate 45-40%.

Abbreviations: DNAns Dinitroanisole; DNB Dinitrobenzene; PETN Pentaerythritol tetranitrate; RDX Cyclonite; TNT Trinitrotoluene.

References:

1) A. Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig, (1933), p 308

2) G. Römer, PBL Rept No 85,160 (1945), pp 17 & 23

3) O. V. Strickland et al, General Summary of Explosives Plants, PB Rept No 925 (1945)

4) T.Urbański, Przemysł Chemiczny 4, 487 (1948).

Amberit (Amberite). One of the sporting propellants: collodion cotton 59, guncotton 13, Ba or K nitrate 19, paraffin 6.0, moisture 1.5, gelatinizer 1.5% [Brunswig, Das rauchlose Pulver (1926), p 134].

Amidpulver (Amidpowder) was a sulfurless black powder substitute invented in 1885 by Gäns of Hamburg. It had the following composition: Am nitrate 38, K nitrate 40 and charcoal 22%. Its composition was modified several times until a powder which was flashless and almost smokeless was obtained. The improved composition: Am nitrate 37, K nitrate 14 and charcoal 49%, was used during WW I as a cannon propellant.

References:

1) Davis, (1943), p 49 2) Bebie, (1943), pp 20-21.

Ammonals (Aluminum haltige Sprengstoffe) are explosives based on Am nitrate, Al and TNT or other organic substances. Ammonals have been used for many years, not only in Germany but in other countries, and for this reason are also described in the general section. Several ammonals were used in Germany for military purposes. They may be considered as substitute explosives (Ersatzsprengstoffe), for example:

Ammonal I. Am nitrate 54, TNT 30 and Al flakes 16%

Ammonal II. Am nitrate 72, TNT 12 and Al flakes 16%

Ammonal B. Am nitrate 93-93.5, charcoal 2-3 and Al 2.5-3.5%.

Ammonal. Am nitrate 91.3, TNT 0.3, Al 1.7 and pitch 6.7%. This composition required a booster for initiation.

(See also Fillers Nos 19, 13-113 and 110).

References:

1) Davis, (1943) p 368 2) PB Rept No 925, (1945) 3) PBL Rept 85,160 (1946) 4) A. Stettbacher, Spreng- und Schiesstoffe Rascher, Zürich (1948), p 88.

Ammoncahlücit. See Wetter-Ammoncahlücit.

Ammoncarbonit (Ammoncarbonite). A type of permissible explosive which may be considered intermediate between carbonites and ammonium nitrate explosives.

Table 1 gives the composition and properties of some of these explosives:

Table 1

Composition (%) and some properties	Ammoncarbonit I (Ref 1)	Ammoncarbonit (Refs 1&3)	Ammoncarbonit II (Ref 2)
Ammonium nitrate	80.3	82	56.4
Potassium nitrate	5	10	-
Sodium nitrate	-	-	7
Nitroglycerin	4	3.8	5.0
Collodion cotton	0.2	0.2	-
Glycerin	-	-	5.0
Carbohydrates (such as starch, flour)	4.5	-	4.0
Coal dust	6	-	-
Alkali chloride	-	-	22.6
Wood meal	-	4	-
Oxygen Balance	-	-	10%
Density	1.11	1.06	-
Velocity of Detonation	3195 m/sec	3380 m/sec	-
Trauzl Test	355 cc	-	210 cc

References:

1) Marshall **1**, p 397, 2, p 495 2) P. Naoúm, Nitroglycerin (1928), p 434 3) Ullmann, Enzyklopädie, v 4 (1929), p 780 4) Davis, (1943), p 352.

Ammondynamit (Ammoniadynamite). A type of straight dynamite containing a considerable amount of ammonium nitrate.
Am nitrate 30.0, NG 63.0, collodion cotton 2.0, wood meal 5.0%; oxygen balance + 1.5%, density 1.44, Trauzl test value 485 cc, Pb block crushing 21.0mm, velocity of detonation 7000 m/sec, heat of explosion (water vapor) 1300 kcal/kg, temperature of explosion 2770°C.

This type of explosive was not very popular in Germany but was used in France and the USA [P. Naoúm, Nitroglycerin (1928), p 349].

Ammongelatine (Ammongelatin). A type of permissible dynamite, such as:

a) Ammongelatine 2: DNT 7-8, Al 1.5-2.5, collodion cotton 0.5-0.7, dinitrochlorohydrin (DNCIH) 21-24, Am nitrate 61-65 and carbohydrates not more than 1.5% (Ref 1).

Note: The Am nitrate may be replaced by Na nitrate to the extent of 8.5% of the entire explosive and the DNCIH may be replaced by NG to the extent of 4% of the entire explosive.

b) Ammongelatine. An explosive permitted after WWI for use in Prussian mines: DNCIH (of which up to 5% of the total explosive may be replaced by NG) 28 to 32, collodion cotton 1 to 3, Am nitrate 45 to 50, alkali nitrate 10 to 15, a nitrocompound of toluene and/or naphthalene and/or diphenylamine 6 to 12, vegetable meal 0 to 2% (Ref 3).

c) Deutsche Ammongelatine. DNCIH, containing 15-20% of NG (such a mixture was called "Nitrochlorin") 30, collodion cotton 3, mixture of DNT and TNT 10, Am nitrate 45, Na nitrate 10, wood meal 2; density 1.45, velocity of detonation 6900 m/sec, Trauzl test value 400 cc, vol of gases at NTP 771 l/kg, heat of explosion 1101 kcal/kg, temp of explosion 2570°, specific pressure 8195 atm, brisance by the Kast formula 82,000 (Refs 2 and 4).

Abbreviations: DNCIH Dinitrochlorohydrin; NTP Normal temperature (0° C) and pressure (760 mm).

(Compare with Ammon-Astralit).

References:

1) A. Marshall, Explosives, v 3 (1932), p 109
2) P. Naoum, Schiess- und Sprengstoffe (1927), p 113
3) P. Naoúm, Nitroglycerin (1928), p 379
4) A. Stettbacher, Spreng- und Schiesstoffe (1948), p 86.

Ammoniak (Ammonia) is described in the general section. The German method of manufacture of synthetic ammonia is described in BIOS Final Rept 1441 (1946).

AMMONIT (Ammonite). A type of ammonium nitrate explosive which has been known for many years and which exists in many varieties. Most ammonites were used as commercial explosives, but some of them have found use in military applications, chiefly as substitutes (see Ersatzsprengstoffe) for explosives based on organic nitrocompounds, such as TNT), or nitric esters (such as NG).

Many types of ammonites were known in Germany before WWII. For instance, Naoúm (Ref 1) describes seven types, Beyling and Drekopf (Ref 3) four types and Stettbacher (See table 2 on next page listing ammonites used during WW II for military purposes and see also under Commercial Explosives).

References:

1) P. Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), pp 119-121
2) A. Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig, (1933), p 246
3) C. Beyling & K. Drekopf, Schiesstoffe und Zundmittel, Springer, Berlin (1936), pp 94-95
4) O.W. Stickland et al, General Summary of Explosives Plants, PB Rept No 925 (1945), Appendix 7, p 77
5) G. Römer, Report on Explosives, PBL Rept No 85,160 (1945), pp 22-4.

Ammonium Nitrate. See Ammonsalpeter.

Ammonium Nitrate Explosives. See Ammonsalpetersprengstoffe.

Ammon-Nobelit (Ammon-Nobelite). A type of permissible explosive used after WWI, such as: a) Am nitrate 78.0, K nitrate 5.0, alkali chloride 8.0, meal 5.0, NG 4.0%; oxygen balance + 11.8%, Trauzl test value, 200 cc. b) Am nitrate 61.0, Na nitrate 3.0, meal 7.5, glycerin 3.0, nitrotoluenes 1.0, alkali chloride 20.5, NG 4.0%; oxygen balance 0.0%, Trauzl test value 215 cc [Naoúm, Nitroglycerin (1928), pp 434-5].

Ammonpulver (Ammonpowder). A propellant first manufactured in 1890 in Austria by incorporating Am nitrate 85 with charcoal 15% and compressing the mixture into large pellets to a density of about 1.4. It was used during WWI by the Austrians and Germans as a substitute for NC propellant and ballistite and was claimed to be very effective and practically smokeless, flashless, and erosionless. On the other hand, it was found to be difficult to ignite, gave rather irregular ballistics and had a tendency to disintegrate on storage due to allotropic change in the Am nitrate at 32° (90°F). In order to minimize irregular ballistics, only 1/3 to 1/2 of the propellant charge consisted of Ammonpulver, the rest being NC propellant. In order to protect the Am nitrate from atmospheric moisture the pellets were sometimes enclosed in a box made of thin sheets of double-base propellant (Ref 1). Note: According to Davis (Ref 3), Ammonpulver contained a small amount of an aromatic nitrocompound in addition to the above listed components.

The Ammonpulver described by Herbst (Ref 2) contained Am nitrate 90 and charcoal 10%. The mixture was compressed in the form of perforated cylindrical pellets 4 to 5cm long and 3 to 4cm in diameter. The ignition temp of the compound was 160-165°, but if substances like iron rust, ZnO or CuO were present the temp was lowered to 80 - 120°

Note: According to CIOS 31-68, p 7, the composition of Ammonpulver used during WW II was as follows: Am nitrate 50, NC (12%N), 22, DEGDN 22, hydrocellulose 5 and centralite 1%

References:

1) Marshall, 3 (1932), pp 88 2) H. Herbst, Chem-Ztg 59, 744-5 (1935) 3) Davis (1943), p 49.

Ammonsalpeter (Ammonium Nitrate) is described in the general section. Its manufacture in Germany at Bitterfeld South and Wolfen plants is described in BIOS Final Rept No 889 (1946).

Ammonsalpetersprengstoffe (AS) oder Sicherheitssprengstoffe. See Ammonium Nitrate Explosives, in the general section.

The German References on this subject include:

1) R. Escales, Ammonsalpetersprengstoffe, Veit, Leipzig (1909)
2) P. Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), pp 114
3) P. Naoúm, Nitroglycerin etc., Williams & Wilkins, Balmore (1928), p 423
4) A. Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933) p 295
5) C. Beyling & K. Drekopf, Sprengstoffe und Zündmittel Springer, Berlin (1936), pp 93-96
6) A. Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948) pp 86-88.

AMMUNITION (Munition). See under Bombs, Bullets, Cartridges Fuzes, Grenades, Mines, Projectiles, Rockets and also in the following references:

1) Johnson, Jr and C.T. Haven, Ammunition, W. Morrow, N Y (1943)
2) Dept of the Army Tech Manuals, TM 9-1985-2 and TM 9-1985-3 (19[redacted]
3) G.M. Ta[redacted]icatinny Arsenal Technical Report 982 (1939) (20 [redacted]einmetall CRA)
4) W.H. Ewart, ibid, 1053 (1940) (20 mm Solothurn CRA)*
5) A.B. Schilling, ibid, 1168 (1942) (105 mm How CRA)
6) A.B. Schilling, ibid, 1228 (1943) (88 mm APC HE CRA)
7) A.B. Schilling ibid, 1238 (1943) (50 mm APHE SC CRA)
8) R.M. Dennis, ibid, 1242 (1943) (20 mm APHV CRA)
9) R.M. Dennis, ibid, 1243 (1943) (47 mm APC CRA)
10) A. B. Schilling, ibid, 1245 (1943) (47 mm APHV CRA
11) A.B. Schilling, ibid, 1247 (1943) (75 mm APC HE CRA
12) R.M. Dennis, ibid, 1248 (1943) (20 mm Inc CRA)
13) A.B. Schilling, ibid, 1250 (1943) (50mm APHV Mk II CRA)
14) R.M.Dennis, ibid, 1253 (1943) (37 mm APHE CRA)
15) A.B.Schilling, ibid, 1256 (1943) (20 mm HE SD CRA)
16) A.B.Schilling, ibid, 1259 (1943) (47 mm HE CRA)
17) A.B.Schilling, ibid, 1263 (1943) (80 mm Sm CRA for Mor)
18) A.B.Schilling, ibid, 1267 (1943) (50 mm APHV SC CRA)
19) A.B.Schilling, ibid, 1270 (1944) (50 mm HE CRA for Mor)
20) R.M.Dennis, ibid, 1271 (1943) (37 mm APHV MB CRA)
21) R.M.Dennis, ibid, 1272 (1943) (47 mm AP MB CRA)
22) R.M.Dennis, ibid, 1273 (1943) (50 mm APHE MB CRA)
23) R.M.Dennis, ibid, 1274 (1943) (50 mm APCHE LC CRA)
24) A.B.Schilling, ibid, 1275 (1943) (20 mm AP Inert Loaded CRA)
25) R.M.Dennis, ibid, 1276 (1943) (75 mm HE CRA)
26) A.B.Schilling, ibid, 1300 (1943) (88 mm HE CRA)
27) R.M.Dennis, ibid, 1305 (1943) (50 mm HE SC CRA)
28) R.M.Dennis, ibid, 1314 (1943) (37 mm HE CRA)
29) R.M.Dennis, ibid, 1318 (1944) (50 mm HE LC CRA)
30) R.M.Dennis, ibid, 1320 (1943) (37 mm APHE MB CRA)
31) R.M.Dennis, ibid, 1326 (1944) (42/28 mm APHV CRA)
32) A.B.Schilling, ibid, 1329 (1944) (28/20 mm APHV CRA of two designs, single-piece body and two-piece body)
33) A.B.Schilling, ibid, 1334 (1943) (75 mm Chem CRA)
34) R.M.Dennis, ibid, 1340 (1944) (80 mm HE CRA for Mor)
35) R.M.Dennis, ibid, 1343 (1944) (75 mm HE CRA for Pak 40 gun)

Table 2

Components and some properties	Designation of Ammonites: No ?*	43A	43B	43c	43C**	No ?	H1	H5	No ?	No ?	No ?	H-2	H-8
Am nitrate	42.0	46.0	56.0	See under Ersatzsprengstoffe	45.0	46.0	50.0	50.0	55.0	52.0	50.0	See under Ersatzsprengstoffe	See under Ersatzsprengstoffe
Na nitrate	9.8	-	8.0		-	-	-	5.0	5.0	8.0	-		
Ca nitrate, $4H_2O$	-	8.0	6.0		10.0	8.0	15.0	15.0	10.0	7.0	15.0		
Mg nitrate, $6H_2O$	8.4	-	-		-	-	-	-	-	-	10.0		
Guanidine nitrate	-	8.0	10.0		15.0	-	-	-	-	-	10.0		
PETN	9.8	-	2.0		-	-	10.0	-	-	-	-		
PH-Salz	-	-	5.0		-	46.0	-	10.0	10.0	-	-		
RDX	30.0	8.0	7.0		-	-	25.0	20.0	20.0	25.0	25.0		
Tetra-Salz	-	-	-		-	-	-	-	-	8.0	-		
TNT	-	30.0	10.0		30.0	-	-	-	-	-	-		
"Vultamol" (emulsifier) (added)	-	0.3	0.3		0.5	-	-	-	-	-	-		
Density (cast)	-	1.58	1.61		-	-	-	-	1.53	1.50	-		
Casting Temperature	-	104	105		-	-	-	-	108	112	-		
Density of Fragments	41m	-	38m		-	39m	-	-	40m	41m	-		
Mining Effect	21m³	-	-		-	-	-	-	-	-	-		
References	5	5	5		4	5	4	4	5	5	4		

*The composition given by Römer (Ref 5, p 22) totals 104

**Ammonit 43C exploded in 1944 on a loading line and its manufacture was discontinued. It was reported that mixtures of TNT with guanidine nitrate were unstable

Most of these mixtures were suitable for loading bombs, grenades and shells.

36) A.B.Schilling, ibid, 1390 (1944) (28/20 mm HEHV CRA)
37) A.B.Schilling, ibid, 1391 (1944) (88 mm HE LC CRA for Flak 41 gun)
38) A.B.Schilling, ibid, 1392 (1944) (88 mm APC LC CRA for Flak 41 gun)
39) A.B.Schilling, ibid, 1398 (1944) (37 mm HE HoC CRA)
40) A.B.Schilling, ibid, 1421 (1944) (75 mm APC HE CRA)
41) J.P.Wardlaw, ibid, 1422 (1944) (80 mm HE CRA for Mor) (Bounding type shell)
42) F.C.Haverlak, ibid, 1430 (1944) (20 mm HE-T CRA for Mauser gun)
43) A.B.Schilling, ibid, 1454 (1944) (75 mm HE HoC CRA for How)
44) A.B.Schilling, ibid, 1455 (1944) (75 mm HE CRA for How)
45) A.B.Schilling, ibid, 1468 (1945) (50 mm HE LC CRA)
46) F.G.Haverlak, ibid, 1478 (1944) (20 mm HE Inc CRA)
47) F.G.Haverlak, ibid, 1481 (1944) (105 mm HE HoC SO CRA)
48) F.G.Haverlak, ibid, 1487 (1944) (75 mm HE HoC CRA for recoilless gun)
49) A.B.Schilling, ibid, 1488 (1945) (150 mm HE HoC CRA)
50) J.P.Wardlaw, ibid, 1490 (1945) (75 mm HE HoC CRA for Pak 40 gun)
51) F.G.Haverlak, ibid, 1498 (1945) (105 mm HE HoC Type C-LO shell CRA)
52) F.G.Haverlak, ibid, 1503 (1945) (75 mm HE HoC CRA for KwK40 gun)
53) F.G.Haverlak, ibid, 1508 (1945) (100 mm APC HE CRA)
54) F.G.Haverlak, ibid, 1516 (1945) (88 mm APC HE CRA for KwK43 and Pak gun)
55) A.B.Schilling, ibid, 1522 (1945) (150 mm HE CRA, separate loading)
56) A.B.Schilling, ibid, 1529 (1945) (150 mm HE A/C CRA with BD fuze)
57) F.C.Haverlak, ibid, 1540 (1945) (75 mm HE HoC CRA for short barrel tank gun, KwK 38)
58) F.G.Haverlak, ibid, 1551 (1945) (150 mm How CRA)
59) F.G.Haverlak, ibid, 1552 (1945) (210 mm HE CRA)
60) A.B.Schilling, ibid, 1559 (1945) (88 mm HE, serrated shell for Flak 18 gun)
61) F.G.Haverlak, ibid, 1575 (1945) (152 mm CP shell and cartridge case with propellant of Russian origin)
62) A.B.Schilling, ibid, 1577 (1945) (240 mm HE shell with PD and BD fuzes; cartridge case and propellant)
63) A.B.Schilling, ibid, 1578 (1945) (75/55 mm HE CRA for tapered bore Pak 41 gun)
64) A.B.Schilling, ibid, 1579 (1945) (75/55 mm AP CRA for tapered bore Pak 41 gun)
65) A.B.Schilling, ibid, 1582 (1945) (100 mm HE CRA for Mor)
66) A.B.Schilling, ibid, 1604 and 1605 (1946) (105 mm rocket assisted HE shell)
67) A.B.Schilling, ibid, 1606 (1946) (128 mm rocket assisted HE shell)
68) A.B.Schilling, ibid, 1607, 1608 and 1609 (1946) (150 mm rocket assisted HE shell)
69) A.B.Schilling, ibid, 1610 (1946) (150 mm rocket assisted AP shell)
70) A.B.Schilling, ibid, 1903 (1954) (30 mm HE and Inc shell for the A/C Mk-108 cannon) (Confidential)
71) Anon, Enemy Bombs and Fuzes, War Dept TM-E9-1983 (1942)
72) Anon, Enemy War Materials Inventory List, Ammunition, Supreme Headquarters AEF (1945)
73) Anon, Recognition Handbook of German Ammunition, Supreme Headquarters AEF (1945).

Note: All Picatinny Arsenal reports except No 1903 are unclassified

Abbreviations AA Antiaircraft; AC Aircraft; A/C Anti-concrete; AP Armor-piercing; A/P Anti-personnel; BD Base-detonating; C Capped; Chem Chemical; CP Concrete-piercing CRA Complete round of ammunition; Flak German designation of Antiaircraft; HC High capacity; HE High explosive; HoC Hollow (shaped) charge; How Howitzer; HV Hyper velocity; Inc Incendiary; KwK German designation of Tank Gun; LC Long case; LO Long ogive; MB Monoblock; Mor Mortar; Pak German designation for Antitank; PD Point-detonating; SC Short case; SD Self-destroying; Sm Smoke; SO Short ogive; T Tracer.

"Amorce" (Toy Pistol Cap). Due to the shortage of fulminate caps during WW II, the Germans used amorces as igniters for some hand grenades. Amorces manufactured by Ferdinand Wicke, Wupertal-Barmen and by Blumberg & Co, Lintorf bei Düsseldorf contained: K chlorate 67.5 to 80.6, phosphorus 12.3 to 8.0, sulfur 8.9 to 5.7 and chalk 11.3 to 5.7%
Reference: BIOS Final Rept 1313 (1947), pp 2-4.

Anagon. One of the early aluminized explosives: Al 5.5, Am nitrate 84.5, K nitrate 1.5, charcoal 8.0, Ba nitrate 0.5% [L. Médard, Mém Artil Fr 22, 596 (1948)].

Ansonitkapseln (Ansonit Caps). Due to the shortage of brass during WW I, the Germans used zinc and zincated iron caps. They were filled with TNT as the base charge and compressed silver fulminate as the primary charge. The ensemble was called Ansonitkapsel. [P. Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), p 185].

Antiaircraft Wind Gun. See Wind Gun.

Antibreak-up Fuze (Antirupture Fuze), such as AZ (24)A was a mechanical impact fuze with a safety arming period of 10 seconds provided by the clockwork gear train. There were two striker systems incorporated: an inertia striker system to operate on impact and an antirupture striker to function in case there was any distortion of bomb or fuze pocket on impact. The two striker systems were located at opposite ends of the fuze separated by a flash channel about 260 mm long. This fuze, as well as the AZ (24), are described in TM 9-1985-2 (1953), pp 135-9. They were used in bomb SC 2500 kg.
(See illustration on next page).

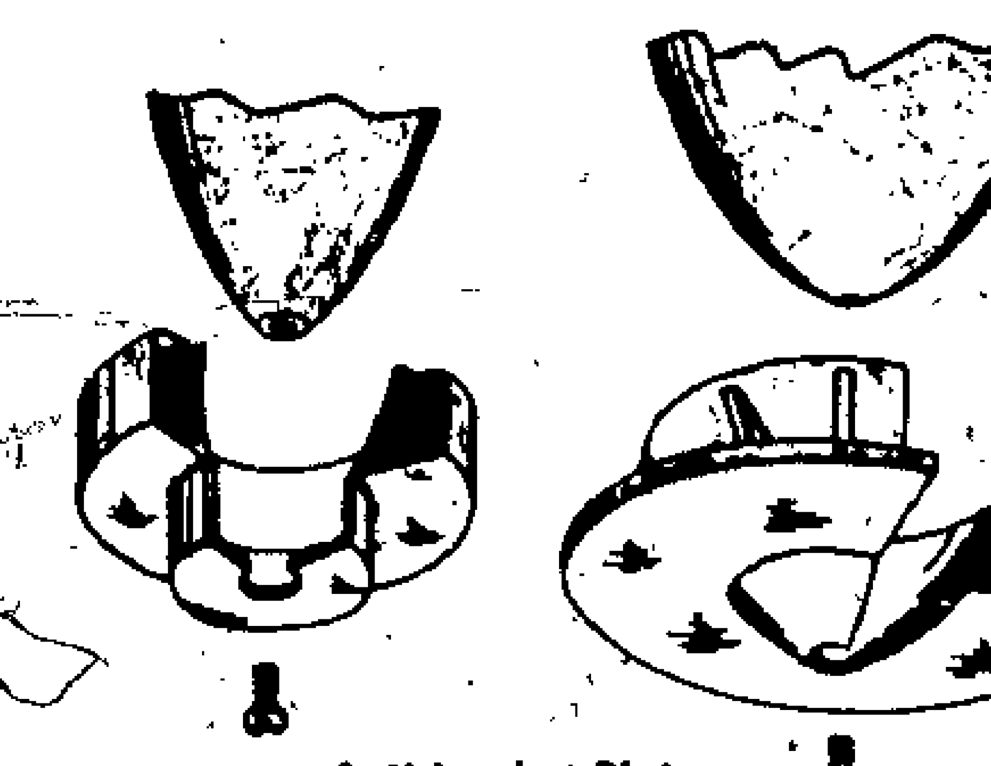
Antidisturbance Fuze (Electrical) was a device designed to function if disturbed after the bomb, dropped from a plane had come to rest. One type, the 50, consisted of a cylindrical case containing an electrical circuit (two condensers, two resisters, a super-sensitive ball-trembler switch and bridge wire of primer) and two charging plungers. The base of the cylindrical case was threaded to receive a gaine. Before dropping the bomb, an electrical charge from the plane was conducted through the charging plungers into the charging condenser. During the flight the charge slowly leaked through a high resister into the firing condenser. If after the bomb had come to rest it was subsequently disturbed, the trembler switch caused the circuit to be closed. This ignited the primer, initiated the booster and detonated the HE charge of the bomb. This also took place when one or both charging plungers were depressed. In this case the current from the condenser by-passed the switch. [TM E9-1983 (1942), file No 2325].
Another antidisturbance fuze, the 50 or Y was much more complicated. Its description is given in TM 9-1985-2 (1953), pp 183-6.
(See illustration on next page).

Antilifting Igniter. See items I and L under Igniter

Antipathfinder Devices. See Pyrotechnic Antipathfinder Devices.

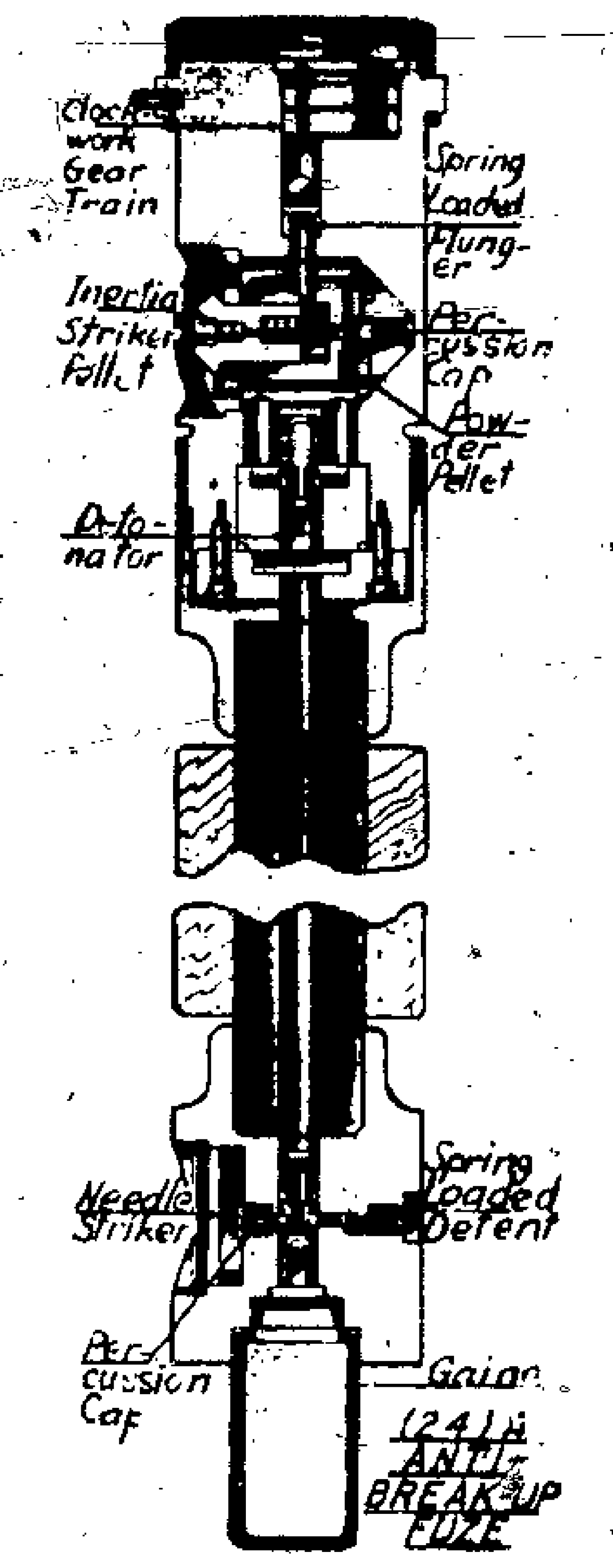
Antipodal Bomber. See Sänger-Bredt Missile.

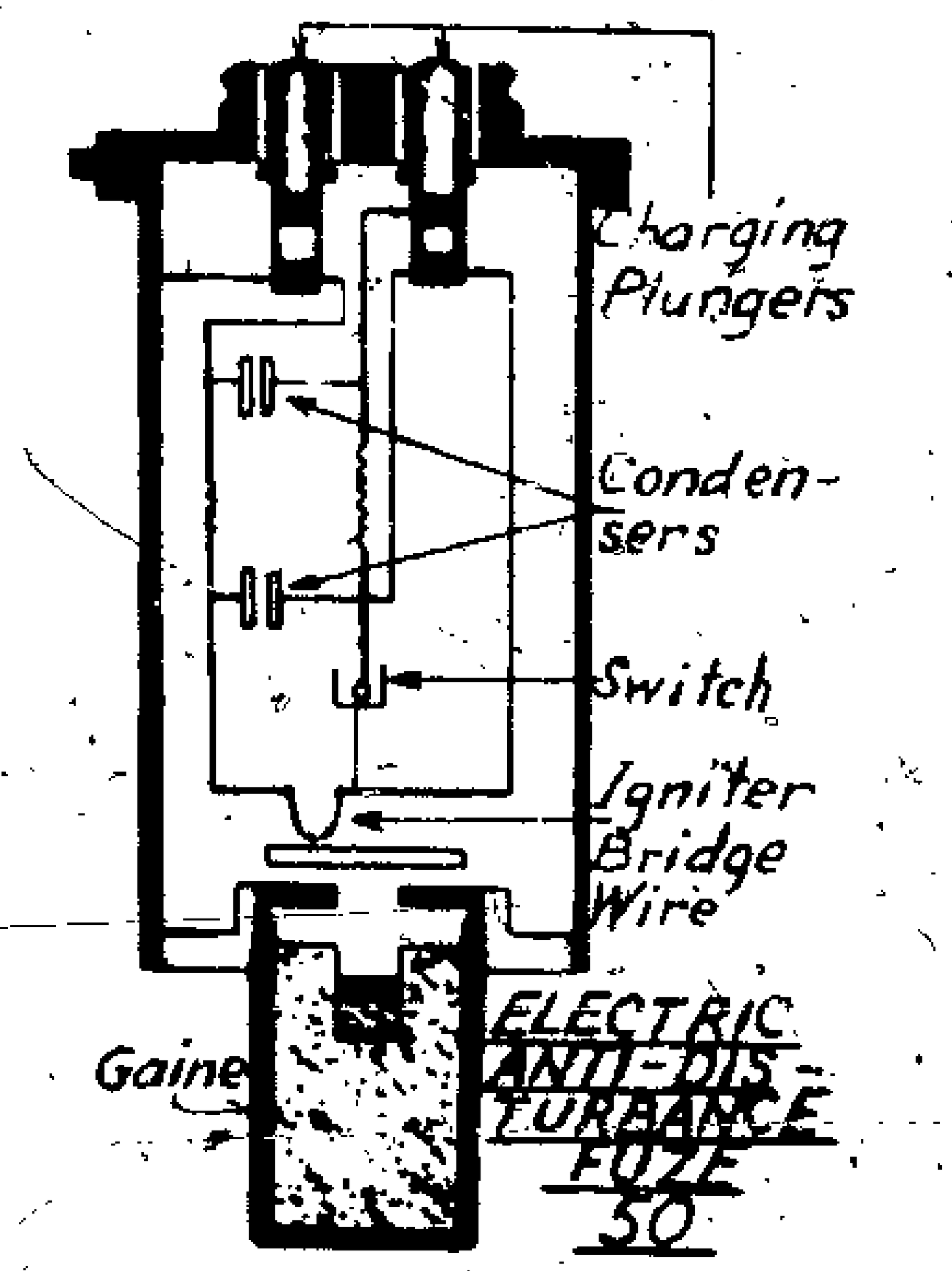
Anti-Ricochet Plates. Circular shaped metallic devices attached to the noses of some aircraft bombs intended to prevent ricochet when striking at an angle of obliquity against very resistant targets (such as armor), or to prevent excessive penetration into less resistant targets (such as concrete or wood) when striking them at an angle close to normal. (See Illustration on next page and also under Kopfring) [TM 9-1985-2 (1953), p 4].



Antiricochet Plates

SC 50 SC 250





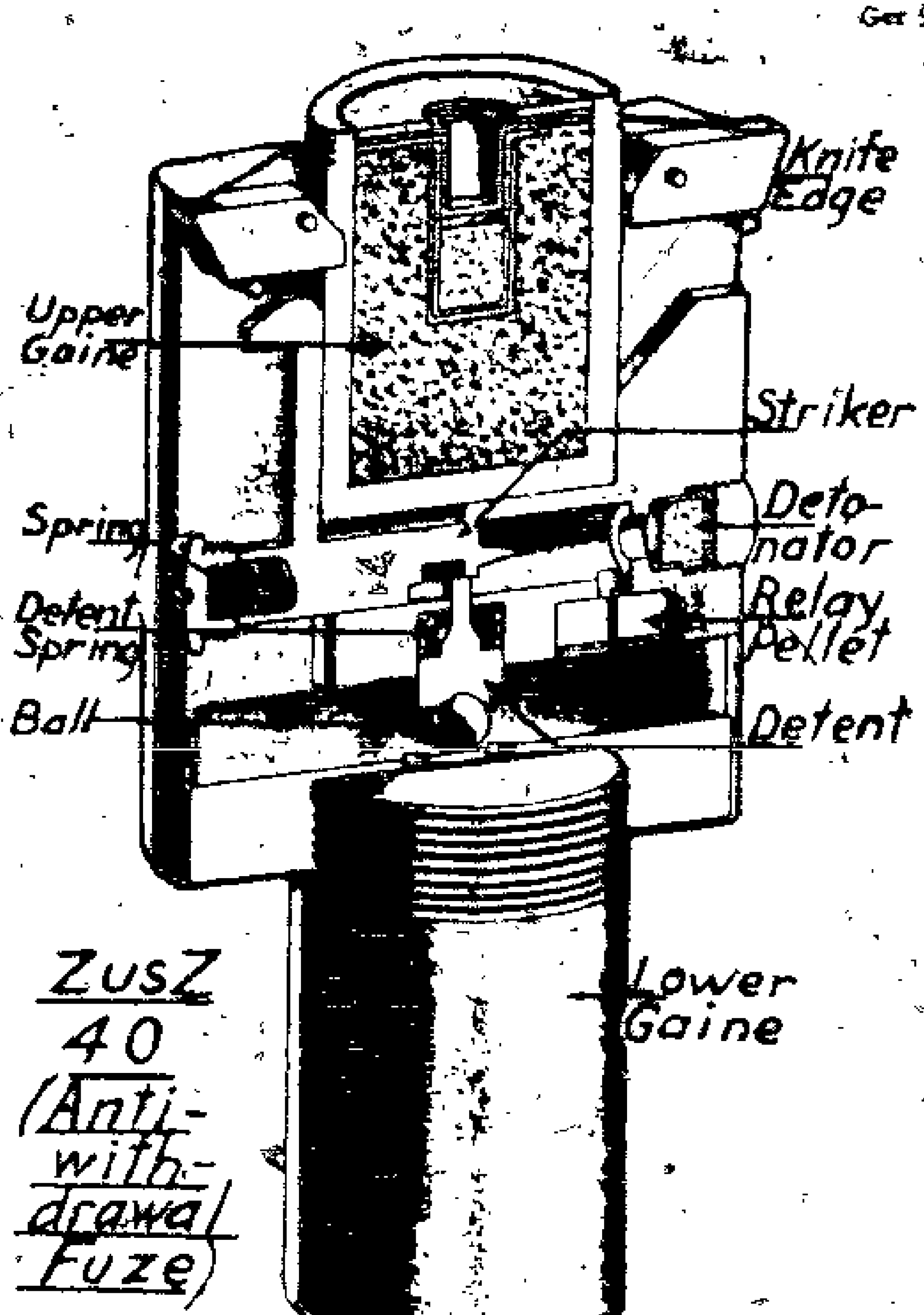
Antiwithdrawal Fuzes (Mechanical) were designed as protective devices to prevent withdrawal of regular time fuzes from bombs. Three types of such fuzes are described in TM 9-1985-2 (1953), pp 177 & 179-181: ZusZ 40, Types I, II and III. The type I fuze consisted of a cylindrical body with a central opening in the upper surface to receive the gaine of the time fuze which it protected, and a second gaine which was threaded into the base of a ZusZ 40. An attempt to withdraw the fuze would cause the steel ball (below the detent spring) to be displaced, thus allowing the striker to hit the detonator. The resulting flash was transmitted through a small channel to the booster and the bomb was exploded. To prevent the withdrawal of the ZusZ 40 when the time fuze was removed, spring-loaded knife edges were placed in the upper part of the device. (See illustration on next page).

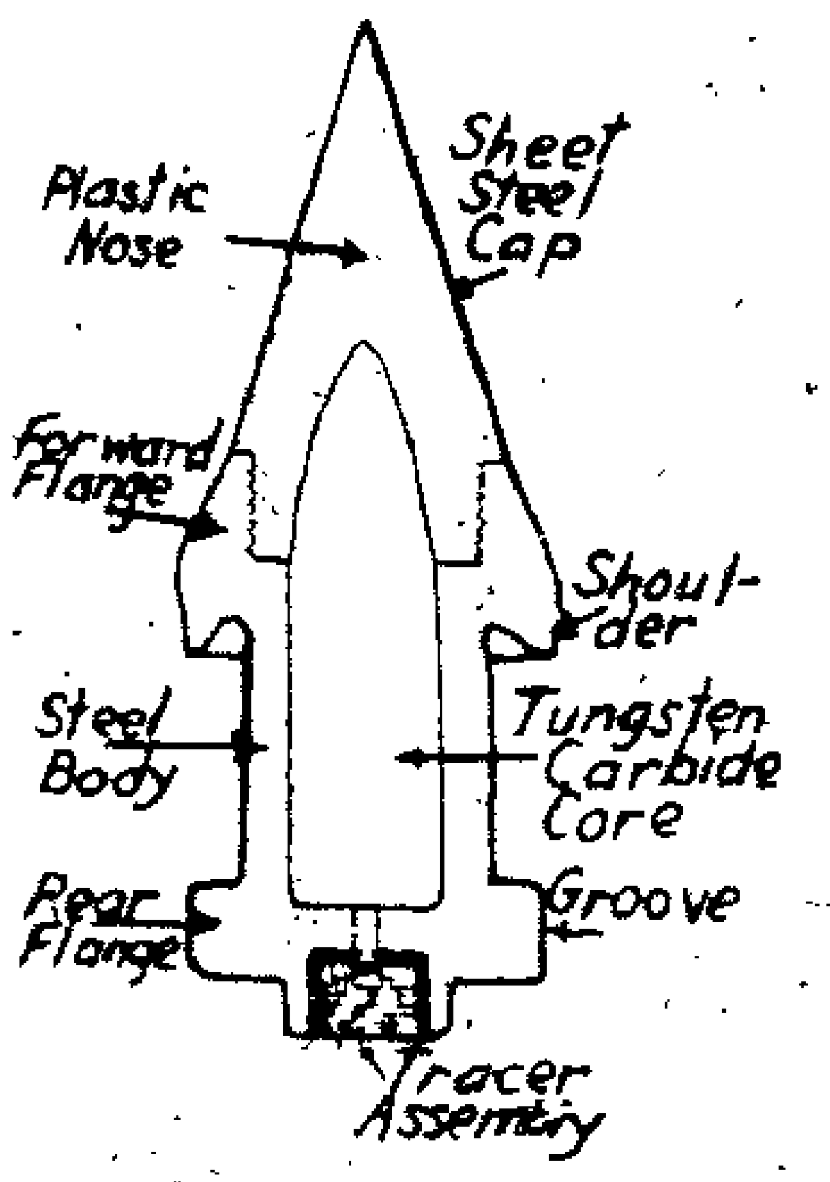
"Anzio Annie" or "Leopold 280 mm Railroad Gun, Model 5 (See under Weapons).

Armored Cars are described in the following references: 1) G.B.Jarrett, "Achtung Panzer", Great Oaks, RD 1, Aberdeen, Md (1948)
2) D.F. von Senger u Etterlin, "Taschenbuch der Panzer", Lehmann, München (1954) (See also under Panzer).

Arit (Arite). A mining explosive reported to be manufd by VEB Sprengstoffwerke, Gnaschwitz. Its approximate composition is NG, pyroxylin, sawdust, TNT and inorganic salts.

Arrowhead (Needle Point) Projectile, such as 5 cm PzgrPatr 40 für 5 cm Pak, was a 50 mm AP proj which consisted of the following components: a pointed tungsten carbide core cemented to a steel body which had forward and rearward flanges, a plastic arrowhead shaped head covered with a sheet steel ballistic cap and a tracer assembly. The forward flange acted as the rotating band, while the rear flange acted as the bourrelet.
The Pzgr 40 was fired from a normal gun. On striking the armor, the ballistic cap, the head and the body with





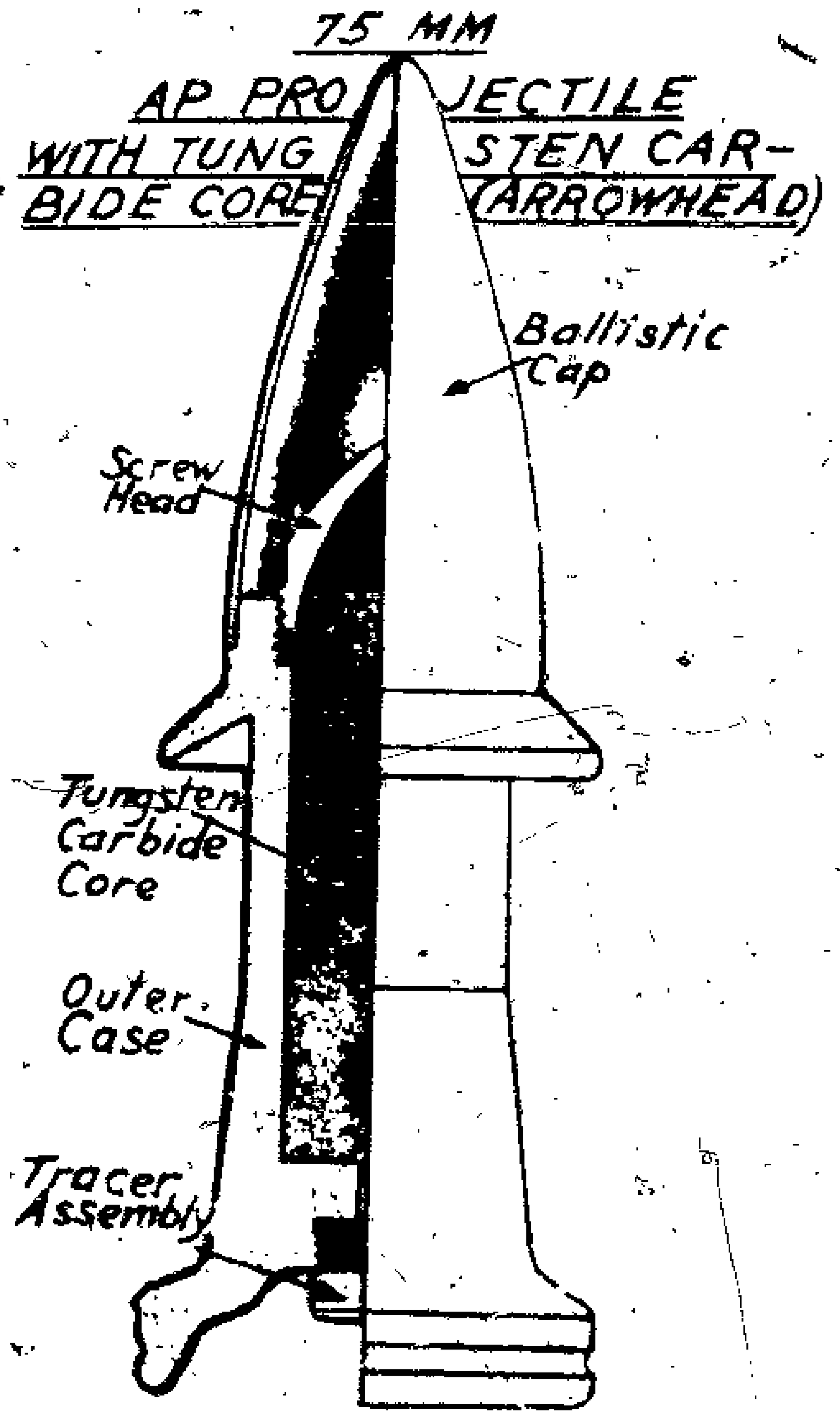
ARROWHEAD PROJECTILE

tracer assembly were shattered thus leaving the tungsten carbide core to penetrate the armor.

By employing the arrowhead design, the weight of proj was about half the conventional Pzgr (HEAP) shell. Due to this lightness, it was possible to develop very high vel-ocities and high armor penetration at short ranges. The proj was, however, very inaccurate at long ranges and the penetration hole was small in comparison with the gun caliber (See also Tapered-Bore Gun Projectile).

There were also 37 mm (3.7 cm PzgrPatr 40), 47 mm (4.7 cm PzgrPatr 40) and 75 mm (7.5 cm PzgrPatr 41) arrowhead type AP projectiles.

References:
1) E.Engleeburg, Ordnance Sergeant May 1944, pp 311-12
2) Anon, Technical Manual TM 9-1985-3, pp 373, 376-7



Arrow Projectile (Pfeilstabiles Geschoss) is a slender, very long, fin-stabilized subcaliber projectile fired from a smooth-bore gun at supersonic velocity. Its development which is described in Ref 1 may be considered as one of the outstanding German achievements of WW II Some of these projectiles were used in the attack on the Maginot Line and were successful in penetrating concrete. Their subsequent use was confined to the Russian front.

ARROW PROJECTILE

References:
1) H.Kurzweg, Die grundsätzlichen aerodynamischen Untersuchungen zur Entwicklung pfeilstabiler Geschosse Schriften der Deutschen Akademie der Luftfahrtforschung, Nr 1059/43 (1943), pp 33-71
2) L.E.Simon, German Research During WW II J. Wiley, N Y (1947), p 191
3) Dept of the Army Tech Manual, TM 9-1985-3 (1953), p 360.

Note: According to H.H.Bullock and G.Coghlan, the above projectile was also called a Needle Shell. A projectile available at the Museum of Picatinny Arsenal was 105/60 mm caliber and about 760 mm long (Compare with Röchling Anticoncrete Projectile).
(See also Gessner Projectile).

Arsenals and Explosives and Ammunition Plants. See Warplants.

Artillerie (Artillery). A list of German cannons etc may be found under Weapons.
(See also Taschenbuch für den Artilleristen published in 1937 by Rheinmetall-Borsig).

Artillery Ammunition (Complete Round). See under Granate.

AS. Abbreviation for Ammonsalpetersprengstoffe. (Explosives based on ammonium nitrate) [Weichelt (1953), pp 39, 375].

AS-3. One of the German priming (igniting) compositions used during WW II in some electric fuseheads. It contained red lead 77, silicon 19, NC suspended in acetone 4% [PB Rept No 95 613 (1947), Section T].

ASN. See under Unterwassersprengstoffe.

A-Stoff (Liquid Oxygen) is described in the general section. It was used in some liquid propellants for guided missiles such as the A-4 (V-2), Taifun and Wasserfall.
Reference: Gollin, Rockets and Directed Missiles, CIOS File No 28-56 (1946), p 3.
Note: According to CIOS 33-13, p 20, the AS-3, which means Artillery School composition 3 (Artillerieschule 3), was an incendiary composition prepared by mixing 75 parts of red lead with 25 p of silicon made into a paste with NC jelly.

Assisted Take-Off (ATO) Units. See under Rocket.

Astralit (Astralite). A type of mining explosive similar in composition to Ammonit and Donarit.
Typical compositions are given in the following Table 3a:

Table 3a

Composition (%) and some properties	Astralit 1	Astralit 2	Astralit 3	Astralit 4	Astralit O N
Ammonium nitrate	84.5	80.0	79.0	68.3	80.0
TNT + DNT	7.0	12.0			-
Vegetable meal	1.0	3.0			-
TNT + DNT + meal	-	-	17.0	27.7	20.0
Charcoal	1.0	1.0			-
Paraffin oil	2.5		-	-	-
Nitroglycerin	4.0	4.0	4.0	4.0	-
Oxygen Balance,%	-	-	+2.5	-	+0.3
Trauzl Test, cc	-	-	390	-	375
Pb Block Crushing, mm	-	-	16.2	-	16.0
Sensitiveness to Initiation (requires)	-	-	No 1 Cap	-	No 3 Cap
Propagation in 30 cm Cartridges*	-	-	12.0cm	-	80cm
Velocity of Deton-ation m/sec	-	-	5400		4900
Density of Cartridge	-	-	1.09	-	1.03
Heat of Explosion, kcal/kg	-	-	957	-	1006
Temperature of Ex-plosion, °C	-	-	2170	-	2270

*See Propagation of Explosion in Cartridges, described in the general section.

References:
1) A.Marshall, Explosives, I, (1917), p 397
2) P.Naoúm, Nitroglycerin (1928), pp 423 & 426.

Äthylphenylurethan (Ethylphenylurethane) was used as an ingredient of some smokeless propellants (as a stabilizer-gelatinizer) [PB Rept No 11,544 (1945)].

Aurol or Ingolin. See T-Stoff.

Ausbauchungsprobe (Expansion Test). See Trauzl Lead Block Test in the general section.

Ausschwitzungsprobe (Sweating Test). See Exudation Test in this and in the general sections.

Azeton (Acetone). See general section.

Azide (Azides) are described in the general section. (See also this section under Bleiazid).

Azoimid (Stickstoffwasserstoffsäure) (Hydrazoic Acid). See general section.

B-4. A vehicle 12' long, 6' wide and 4' high provided with a 6 cylinder engine (in the rear), a radio and a space for the driver. After loading the vehicle with some demolition charges, the driver took the car (max speed 30 mph) as close as possible to the target marked for destruction (such as a barbed wire, road block, pillbox, bridge, etc), dropped the demolition charges, set the time fuse and then rushed back. These vehicles were easy targets for the Allies' artillery.
Reference: Anon, Field Artillery J, 34, 505 (1944).

Ba (Bochum 240 Missile). See Natter Ba 349A and 349B.

Baelit. One of the mining explosives: Am nitrate 85 and TNT 15%. [E.Colver, High Explosives (1918), p 249].

"Balter". See "Hetzer" armored vehicle listed under Panzer.

Ballistische Beständigung (Ballistic Stability). See general section.

Ballistit or WPC/89 (Würfelpulver/89) (Cube Powder of 1889) (Ballistite). Dark grey propellant consisting of equal parts of NG and collodion cotton together with 0.5% to 1% of DPhA and vaselin. It was adopted in 1889 by the German Navy. Less erosive compositions were introduced in 1897 and 1900, under the designation of RPC/97 and RPC/00, where RP stands for Röhrenpulver (tube powder) [Marshall, v1 (1917), p 303].

Bandlech Pulver was prepd by compressing the Schultze Pulver into grains of high density [L.Gody, Traité des Matières Explosives, Namur, (1907), p 469].

Bangalore Torpedo (In Rohr gefüllte Reihenladung). See general section.

Bär (Bear). One of the experimental tanks (See under Panzer).

Baratol. See general section.

Barytique (Poudre). Under this title, Daniel, Dictionnaire (1902), p 57 gives a mixture of 8 parts of black powder with 2 parts of Ba nitrate. It was used in the 1860's in larger caliber guns.

Baumwolle (Cotton). See under Cellulose in the general section.

Behelfsmine (Improvised or Makeshift Mine). Several land mines used by the Germans during WW II were made from items not specially designed for mines. For instance Behelfsmine W-1, A/P was improvised from captured 50 mm mortar shell. Several improvised land mines are described on pp 279-83 of TM 9-1985-2 (1953).

Beiladung. See Booster Charge and under Ignition.

Bellit (Bellite). One of the Sprengel type explosives. It was also used in England and other countries (See in the general section).

Bent Barrel. See Krummerlauf.

Beobachtungsgeschosspatrone (Observation Round). Fixed round with a projectile which had a core of HE, a fuze in the central portion and a phosphorus filler in the base. The purpose of this round was to indicate the exact location of a hit by means of a puff of smoke (produced on ignition of the phosphorus).
Reference: A.J.Dere, Ordnance Sergeant, Dec 1943, pp 357-61.

Berclavite B. According to L. Médard, Mém Artil Fr 22, 596(1948), the Berclavite B is one of the older aluminized explosives: Am nitrate 79.5, DNT 5, NG 5, collodion cotton 0.5, Al 5 and cellulose 5%; power by the French lead block expansion test (modified Trauzl test) is 125, taking the value for picric acid as 100.

Berger-Mischung (Berger Mixture). A smoke-producing mixture composed of 2 parts of zinc dust and 3 pts of hexachloroethane [U S War Dept Tech Manual, TM 30-506 (1944), p 23].

Bergmann-Junk Stability Test. See general section under Stability Tests.

Besatz oder Verdämmung (Tamping or Stemming). See general section.

Beschussprobe (Shooting Test, called in the U.S.A. Rifle Bullet Test). It is similar to the U S test described in the general section. The German test is conducted according to Stettbacher, Spreng- und Schiesstoffe (1948), p 121 by firing a standard infantry rifle from a distance of 25 meters.

Biazzi Continuous Process for the Production of Nitroglycerin and Nitroglycol as used at the Dynamit A-G, Schlebusch Fabrik is described by Drs W.B.Littler & D.B.Clapp, BIOS Final Rept 1842 (1946) (See also under general section).

Bichel Explosives. Several compositions were patented by C.E.Bichel at the end of the last century, among them: a) NG 100 parts mixed with 10 p of sulfurated turpentine, b) Na nitrate 90-100 p mixed with 5 p of nitrocumene and 10 p of sulfurated tar oil, c) Am nitrate 86 p mixed with 8 p of TNT and 6 p flour or starch.
Reference: Daniel, Dictionnaire (1902), pp 67-8.

Big Bertha Gun. See general section.

Bikarbit (Bicarbite). A type of permissible explosive containing large amounts of sodium bicarbonate and small amounts of NG, patented by W A S A-G before WW II. These explosives, although they contained a large amount of $NaHCO_3$ and a small amount of NG, were very easy to initiate. Mixtures containing as much as 95% $NaHCO_3$ and as little as 5% NG could still be initiated by ordinary blasting caps.

The following are the composition and properties of one of the bicarbites: NG 15, $NaHCO_3$ 50 and NaCl 35%; temp of explosion 400°, veloc of detn 2500 m/sec, heat of explosion 162 kcal/kg, 4-1:35, Trauzl test value 30 cc for a 10 g sample, specific pressure 610 atm x l/kg, brisance value (Kast) B = d x (sp press) x (vel of det) x 10^{-6} = 2.06, gap test value (Detonationsübertragungsprobe oder Schlagweiteprobe) 40 cm, required for initiation at least a No 2 blasting cap, volume of gases evolved on explosion of 1 kg is 258 l at 20° and 760 mm Hg (H_2O in vapor phase). Composition of gases: CO_2 46.1, H_2O 43.2, N_2 9.2, and O_2 1.5%.

Note: When a more brisant explosive is desired, the amount of NG is increased, the amounts of NaCl and $NaHCO_3$ are decreased and some fuel and oxidizer are incorporated.

The following mixture may serve as an example of such an explosive: NG (slightly gelatinized) 30, $NaHCO_3$ 40, NaCl 12.5, wood meal 4.5 and $NaNO_3$ 13.0%; temperature of explosion 1400°, veloc of deton 4000 m/sec, d 1.4, Trauzl test value 124 cc for a 10 g sample, gap test value 30 cm; could be initiated by a No 2 blasting cap.

The bicarbites were comparatively expensive, but they proved to be very safe for use in gaseous or dusty coal mines.
Reference:
C.Beyling & K.Drekopf, Sprengstoffe und Zündmittel, J. Springer, Berlin (1936) (Lithographed by Edwards Bros, Ann Arbor, Mich), pp 145-146.

Biscuit Mixture A. See under Amatol 39.

Black Powder. See Schwartzpulver.

Blasting Caps. See Detonators.

Blasting Gelatin. See Sprenggelatine.

Blättchenpulver oder "B" Pulver (Leaf Powder or Flake Propellant). According to Stettbacher, Spreng- und Schiesstoffe (1948), p 41, it was prepd by colloiding a mixture of 3 parts of guncotton (Schiesswolle) of N content minimum 13.1% and 1 p of soluble NC (Kollodiumwolle) of N content 12.6%. After incorporating into mixture 0.5% of the stabilizer (DPhA) and 1% of flash-reducer (Na oxalate), the mass was flaked and dried. The resulting flakes (which were 0.3 mm thick and had a surface of 1.3 mm^2) were surface-treated with centralite and finely pulverized graphite in order to make them progressive burning.

Bleiazid (Lead Azide) (L A). See general section, under Azides. It was used in Germany in some priming and initiating compositions.

L A was prepd in Germany during WW II from sodium azide and lead nitrate in the presence of dextrin, in the following manner:

a) Fifty liters of water containing 1.5 kg of sodium azide was added slowly to 60 l of an aqueous solution containing 5 kg of $Pb(NO_3)_2$ and 0.15 kg of dextrin, preheated to 60° and stirred by air. After adding the first 5 liters, there was a pause of 5 minutes. The remaining 45 l, was added during the next 45 minutes, and the stirring was continued for 15 minutes, while the mixture was cooled by means of cold water circulating through the jacket.

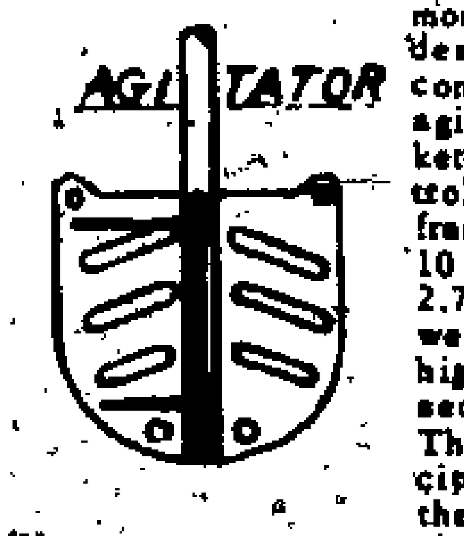
b) Following this, the reactor was tipped onto a filter and the L A retained on a filter cloth made of horse hair. Suction was applied

c) After rinsing the L A with several portions of water, it was placed on sheets of paper attached to frames and dried to a moisture content below 0.1%. Drying was done by blowing air for 48 hrs at 45-50° through the chamber containing the frames.

d) After cooling to 20°, the contents of each sheet were transferred to a graphited cardboard dish. The desired amount of dried L A was added to the same dish, which was then sent to detonator manufacturing plant. (Yield was about 3.3 kg per batch).

In order to destroy any L A remaining in the mother liquor, about 5 liters of nitric acid (5° Be) and about ½ l of concd Na nitrite soln were added per batch of L A.
Reference: PB Rept 95,613 (1947), Sections O & P.

Notes: According to L.M.Sheldon, "Manufacture of Initiating Explosives, etc", CIOS Rept 27-38 p 3, the manufacture of L A at the Wolfratshausen Plant of Dynamit A-G was conducted in a large, well-polished, stainless steel, round bottom, cylindrical vessel, jacketed for circulation of heating or cooling water or brine. Agitation was conducted by one centrally located shaft having 4 blades as shown on the attached drawing. This agitator could be raised or lowered as required to provide the most effective position for securing the desired mixing. For discharging the contents of the reaction vessel the agitator shaft was raised clear of the kettle which was then tilted by a control wheel located on the supporting framework. Stock solutions, 9 to 10 % by weight of lead nitrate and 2.7 to 3.0% by wt of sodium azide were kept in large vessels placed higher than the reactor in order to secure the flow of liquids by gravity. The correct volume for each precipitation charge was obtained by the use of calibrated glass bottles. Flow rates were controlled by manually operated stopcocks. Before proceeding with precipitation the alkalinity of the sodium azide solution was checked by titrating with normal sulfuric acid soln. To be acceptable for use, 50 ml of azide soln required 8 to 10 ml of acid to reach the phenolphthalein end point. If the soln was not sufficiently alkaline some dilute sodium hydroxide was added to the stock soln and the titration repeated. Ordinary tap water was used for making the stock solutions.



In carrying out an individual precipitation, the volume of solution required to give 4.5 kg of actual lead nitrate (500 l when using a 9% soln) was drawn from the supply tank and measured in a calibrated glass bottle from which it was transferred to the reactor. (This amount of lead nitrate is about 18% in excess of that theoretically required). After heating the soln to about 50° some dilute sodium hydroxide was added until the soln became neutral to methyl orange, as determined by a spot plate test. After neutralization, 150 g of potato dextrin (which had previously been dispersed in warm water) was added to the soln.

The correct volume of sodium azide soln to give 1.5 kg of actual material (500 l when using a 3% soln) was measured in a calibrated glass bottle from which it was discharged through an adjustable stopcock into the reactor, while constantly stirring the soln and maintaining it at 50°. The rate of flow was controlled so that the total quantity of Na azide soln was added at a fairly uniform rate over a period of about 1 hour.

After addition of the Na azide soln had been completed, the agitator was stopped, the lead azide allowed to settle and the mother liquor decanted by tilting the vessel. After giving one dilution wash directly in the reaction vessel, it was tilted and the precipitate transferred by means of a jet of water onto a large cloth filter supported on a natural drainage filter. After rinsing the lead azide with three displacement type washes, the cloth was folded over the azide and the ensemble placed in a plastic bucket which was carried to the storage area. The yield was about 3.3 kg of dextrinated lead azide.

A sample of each batch was sent to the laboratory where the crystals were examined microscopically and compared with acceptable standards. Then part of azide was dried and its loading density was determined.

For destruction of unwanted L A, it was treated successively with a 15% nitric acid soln and an 8% Na nitrite soln.

Note: Crystalline structure of L A is described by G. Pfeffetkorn in the Zeitschrift für Naturforschung 3a, 364 (1948).

According to W.Schneider, Sprengtechnik No 10-11, pp 185-196 (1952) and Explosivstoffe No 1-2, pp 1-10 (1953), technical L A (purity 92-94%) used in German Sprengkapsel A and Sprengkapsel B becomes dead-pressed if the loading pressure exceeds about 900 kg/cm² (about 12,800 psi), depending on conditions. Perfectly dry L A can stand higher pressures without being dead-pressed, but L A con-

mining mixture is easier to dead-press. Crystal size also affects the pressure at which dead-pressing occurs.

Bleiblockausbauchung (Trauzlsche Probe). **Bleiblockprobe nach Trauzl oder Bleizylinderprobe nach Trauzl** (Trauzl Lead Block Test). See general section and the books of Stettbacher.

Bleiblockprobe. Same as Bleiblockausbauchungsprobe, which means Lead Block Expansion Test.

Bleiblockstauchungsprobe (Lead Block Compression Test); **Stauchprobe.** See Crusher Test in the general section.

Bleimonoxyd (Lead Monoxide), PbO. See general section.

Bleinitrat (Lead Nitrate). See general section.

Bleioxyd, rotes oder Bleioxydoloxyd (Red Lead Oxide), Pb_3O_4. See general section.

Bleioxydul (Lead Suboxide), Pb_2O. See general section.

Bleiperoxyd (Lead Peroxide), PbO_2. See general section under Peroxides. Was used during WW II as one of the ingredients of fusehead compositions such as in the Spak Fuseheads of high tension: PbO_2 33, Al (crushed flake) 33.5, special Mg alloy 33.5% [PB Rept No 63,877 (1946), pp A3/34 and A3/35].

Bleipikrat (Lead Picrate) (L P). See general section under Picrates; was used in Germany for the preparation of ignition mixtures in fusehead manufacture. The following method was used for the preparation of lead picrate by the action of lead nitrate on picric acid:

Place 8 l of lead nitrate solution (containing 180 g per liter) into a small stainless steel vessel (V2A steel), similar in construction to those used in lead azide manufacture, and provided with a wooden stirrer. Add 15 l. of ice water so that the temp in the vessel is about 6°. Feed in gradually (within 5 minutes) with stirring, 15 l of picric acid solution containing 10 g P A per liter. Add 7-8 l of cold water and allow to settle for 4 hours. Decant the liquor, transfer the slurry to a calico filter cloth placed over a Nutsch or large porcelain vacuum filter with sloping sides. After allowing the slurry to settle until the surface of the L P is just distinguished through the mother liquor, start the vacuum pump and let it run for 3-4 hours. Lift the calico filter and transfer the L P to a stainless steel carrying pot containing 10 l of 96-98% ethanol denatured with 2% of methanol, together with 500 ml of 30% aqueous lead nitrate solution. After thoroughly mixing the ingredients (by means of a wooden spatula), transfer the slurry back to the calico filter cloth on the Nutsch, allow to settle for about ½ hour and then operate the vacuum pump for 1 to 2 hours.

Note: The extent of the drying on the filter should be governed by the fact that the paste has to be soft enough to smear in a fairly thin layer on paper for subsequent drying.

Place the calico filter cloth containing the L P in a papier-mâché bucket and transfer it to the drying house. By means of a wooden spatula, smear the moist L P upon a double sheet of paper 2' x 3', placed on the cloth of a drying frame. Dry the material for 4 hours, starting at room temp and raising it to 40° and finally to 60°.

Note: Caking usually results if the temperature is raised too rapidly.

Transfer the Lead Picrate into papier-mâché containers (yield of dried material should be about 2.2 kg with Pb content about 62%), provided with rubber stoppers. Screen the material, by placing 500 g at a time, together with a rubber stopper (about 1 ½" diam and 2" high) into a cylindrical sieve 10" diam by 6" deep, provided with a silk sieve cloth, 600 meshes per sq cm. Store the sieved material in stoppered papier-mâché or rubber containers until ready to use.

Note: After finishing the precipitation of the L P, the vessel should be cleaned before being used again by stirring with 4 l of 5° Be nitric acid and 100 l of water.

References:

1) G. Ashcroft et al, Investigation of German Commercial Explosives Industry, B I O S Final Report No 833, Item No 2, London, H M Stationery Office (1946); PB Rept No 63,877 (1946), p A3/27

2) Anon, PB Rept No 95,613 (1947), Section D.

Bleiplattenprobe. See Lead Plate Test in the general section.

Bleisalpeter (Lead Nitrate). See general section, under Nitrates.

Bleitrinitroresorcinat oder Bleistyphnat (Lead Trinitroresorcinate or Lead Styphnate) (L St) Blei Salz des Trizins, Trizinat oder Trizinat. See general section under Styphnic Acid and also the references listed below. One of the methods of prepn used in Germany during WW II was as follows:

Trinitroresorcinate (TNR), called Trizin, (72 kg) was stirred into 120 l of water containing 12 kg of MgO until the TNR dissolved. Then the solution was diluted with water until it contained 2.4 kg TNR for each 40 l of solution. The resulting mixture contained magnesium trinitroresorcinate.

To 40 l of the above mixture, preheated to 60° and stirred in a vessel, was added gradually (during 20 minutes) 12.5 l of an aq solution containing 4 kg of lead nitrate. This gave lead styphnate. After allowing the mixture to stand and cooling it to 20°, the mother liquor was decanted leaving the ppt of L St. As some L St remained in the mother liquor, it had to be destroyed. This was done by adding some sodium carbonate which transformed the L St into Na styphnate and precipitated the lead as $PbCO_3$.

After removing the $PbCO_3$, the remaining liquid was acidified with waste acid and the resulting styphnic acid reduced to a non-explosive triamine by means of iron filings (Ref 2).

According to Stettbacher (Ref 3), L St may be prepd by mixing the boiling solns of trinitroresorcinol (previously neutralized with Na carbonate) and lead nitrate.

According to Naoúm (Ref 1), L St has been used as an initiating explosive in Germany since about 1920 when the so-called Trizinatkapseln (q v) were put on the market by the Rheinisch-Westfälische Sprengstoffe A -G.

Several types of initiating compositions used by the Germans during WW II contained L St.

(See also under Primary and Initiating Compositions).

1) P. Naoúm, Schiess- und Sprengstoffe (1927), p 186

2) PB Rept 95,613 (1947), Section N

3) A. Stettbacher, Spreng- und Schiesstoffe (1948), p 98.

Note: L.M.Sheldon, Manufacture of Initiating Explosives, etc, CIOS Rept, File No 27-38 (1945), pp 9-11 describes the method of manufacture of L St at Wolfratshausen Plant, Dynamit A -G:

a) 120 kg of TNR was dispersed in 350 l of water and

20 kg of MgO was added. The mixture was heated to 60° and held for a short period until a solution was obtained. Before use the solution was filtered through a muslin cloth and then diluted to 6° Bé and allowed to settle for 10 hours during which time the temperature dropped to 25-30°.

b) In carrying out the actual precipitation, 86.4 l of 6° Bé soln was decanted from the storage vessel and transferred to the precipitating vessel where it was heated to 60°. Then, 22.70 l of lead nitrate soln (31° Bé or 34% by weight) was added over a period of 20-30 minutes maintaining the temperature at 60° during the entire addition period. As soon as all of the L N soln had been added the contents of vessels were cooled to 25° as rapidly as possible and the agitation was stopped in order to allow the L St to settle. After removing the mother liquor by decantation two dilution washes were given to the precipitate directly in the vessel. Then the product was transferred by means a stream of water onto a cloth filter where it was thoroughly rinsed using the same technique as for dextrinated L A. The yield of L St was about 8 kg.

According to C.S.Livingston et al, CIOS Rept No 24-3, the following method of manufacture of L St was used at Troisdorf Plant, Dynamit A -G:

Into a stainless steel kettle of about 10 (British) gallon capacity (about 45.4 liters), provided with an agitator, were introduced 40 l of water, 2.4 kg of styphnic acid and 0.44 kg of magnesium oxide. The formation of magnesium styphnate developed heat, and when the temperature reached about 55° C, a solution of 4 kg of lead nitrate in 12.5 l of water was run in. The yield was 3.6 kg of L St.

In all the above methods of manufacture of L St the vessels were similar to those used for the manufacture of L A.

For the destruction of L St in the mother liquor, an excess of sodium bicarbonate was added and, after mixing thoroughly, iron filings followed by sulfuric acid were added.

Bleitrizinat. Same as Bleitrinitroresorcinat.

Bleizylinderprobe nach Trauzl (Bleiblockausbauchungsprobe). See Trauzl Lead Block Test in the general section.

"Blitzpulver". According to Stettbacher, Spreng- und Schiesstoffe (1948), p 99, it is one of the names for Nitrodiazobenzeneperchlorate, $C_6H_4(NO_2)N_2 \cdot ClO_4$, which is described in the general section under Diazobenzeneperchlorate.

Bobbinit. See Bobbinite in the general section.

Bohrpatrone 02 (BhrPatr 02) (literally Drill Cartridge of 1902). A demolition charge consisting of 75 g of TNT used at the time of WW I for military pioneer work. It replaced a similar charge made of picric acid and called Bohrpatrone 88 [Colver, High Explosives (1918), p 25].

Bohrpatrone 28 (Drill Cartridge of 1928). A blasting cartridge, described under Demolition Charge. According to TM 9-1985-2 (1953), p 277 the charge was used also in antipersonnel land mines such as Stockmine.

Bomb Containers. See under Containers.

BOMBE (Bomb). Table 3b gives the designations of some German bombs and their English equivalents.

Table 3b

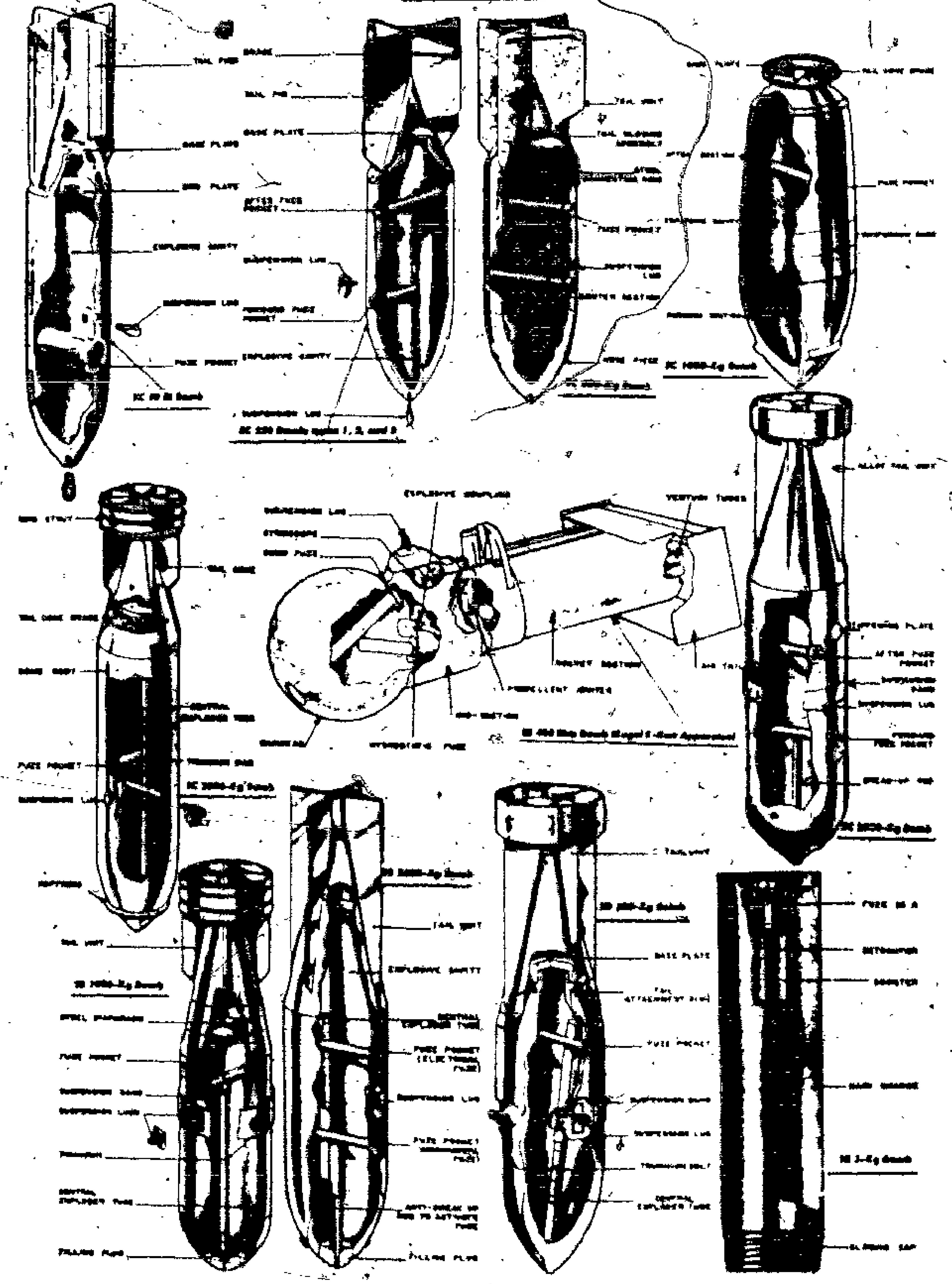
BLZ	Blitzlichtcylindrische	Cylindrical photoflash bomb
BT	Bombea Torpedo	Torpedo bomb
KC	Kampfstoffcylindrische	Chemical cylindrical bomb
NbC	Nebelcylindrische	Cylindrical smoke bomb
PC	Panzerdurchschlagcylindrische	Armor-piercing (AP) bomb
PD	Panzerdickwandige	Armor-piercing (AP) bomb, thick walled
SA		High capacity (HC) bomb (Bomb of maximum blast)
SB	Sprengbombe	High-explosive (Demolition bomb) of high capacity
SBe	Splitterbeton	Concrete fragmentation bomb
SC	Sprengcylindrische	High-explosive cylindrical (General purpose) bomb
SD (klein)	Sprengdickwandige (klein)	Anti-personnel (Small) bomb
SD	Sprengdickwandige	High-explosive thick walled (Semi-armor piercing fragmentation) bomb
SP	Splitter	Fragmentation (Anti-personnel) bomb
ZC	Zementcylindrische	Cement, cylindrical bomb.

Note: The two principal German HE bombs were SC and SB. The SC, or general purpose bombs, had loading factors of 50-55% and because of their destructive quality were used primarily for general demolition. These bombs were usually of three piece steel construction, with the nose being welded to a tubular body and the sheet steel or alloy tail being attached to the bomb body by screws or rivets. The SC bombs were not streamlined. The SD bombs, being either AP or SAP, had a loading factor of about 35% and, because of their penetrative qualities, were used primarily against ships or fortifications. The bombs were streamlined and had thicker walls than the SC. They were usually drawn or forged in one piece. A tail extension with a dummy fuse head was sometimes attached to give the bomb a more streamlined appearance.

Other bombs SA, SB, SBe, etc may be characterized as follows: The SA and SB bombs were thin walled with loading factors as high as 80%. They were designed to give maximum blast effect. The SBe bombs had thick concrete walls reinforced with steel and their loading factor was about 20%. They were filled with a low power explosive and were used for the same purpose as SD s. The PC bombs were AP and used primarily against ships and fortifications. They were slightly streamlined with a heavy nose (hardened cast steel) and heavy walls (cast steel) with the thickness decreasing toward the base of the bomb. Their loading factor was about 20%. The PD bombs were thinner, longer, had thicker walls than PC s and their loading factor was about 15%. They were more penetrating than PC s. The BT was designed along lines similar to a torpedo except for the after section where there were three large tail fins. The missile was put into production during the last two months of the war, but was never used operationally. The ZC bombs, such as ZC 10 kg and ZC 50 kg were practice

Ger 15

BOMBS



Ger 16

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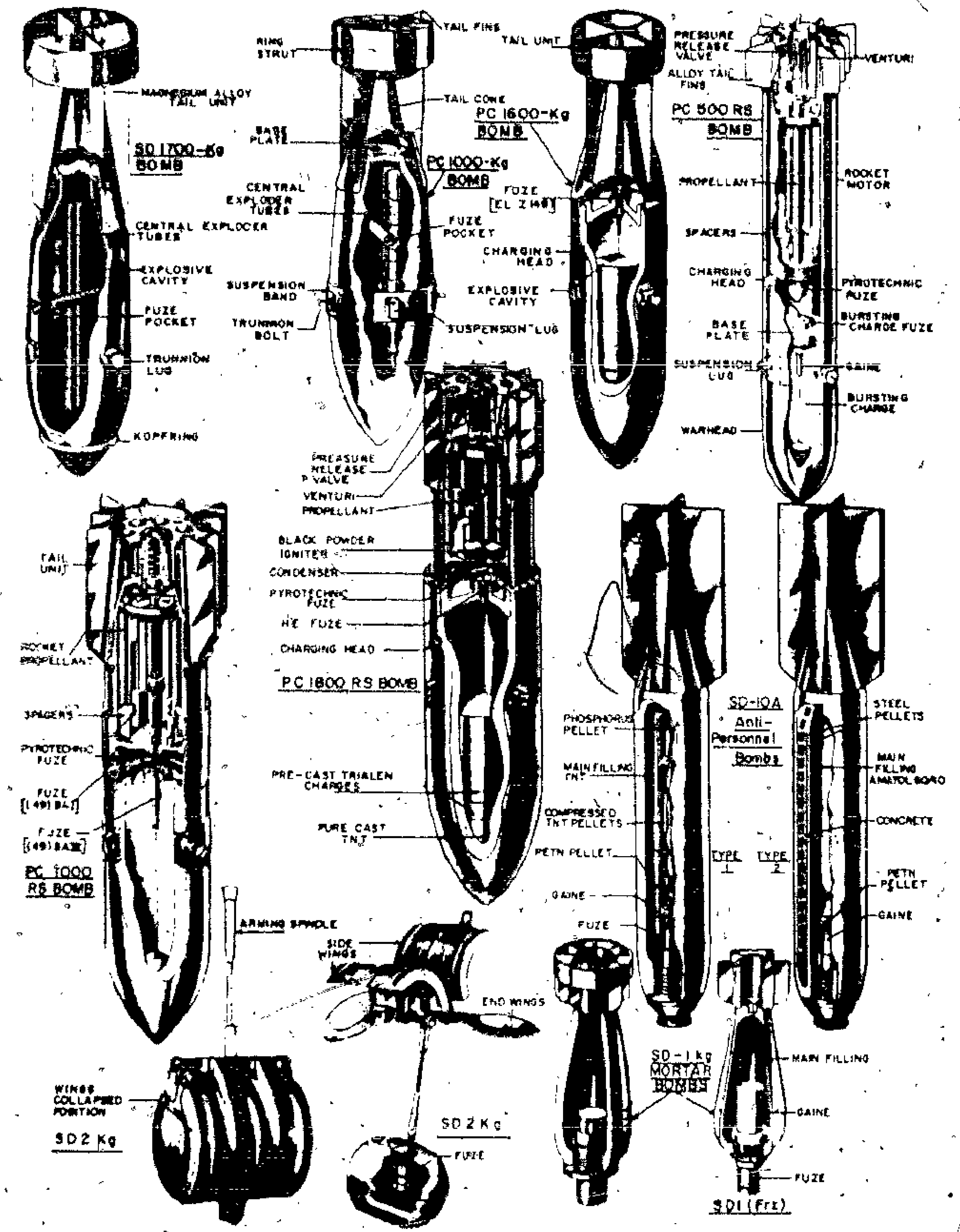


bombs constructed from concrete. The BLZ, KC and NbC bombs resembled in appearance the SC bomb but had different fillings. The SP, fragmentation, A/P bomb is not described in TM 9-1985-2 (1953)

The following bombs are described in the U S Dept of the Army Technical Manual, TM 9-1985-2, German Explosive Ordnance, Washington, D C (1953) p 1 to 124.

1) SC 50 kg Bi was filled with 24.4 kg of cast TNT, amatol or trialen (p 6)

Note: TM 9-1985-2 (1953) does not give the German equivalent of Bi but simply says that the bomb had a one-piece cast steel body machined, all the fittings were welded in place.

2) SC 50 kg Grade I - Ja, L, and Stabo were filled with 21 to 25 kg of cast TNT, powdered amatol or cast trialen (p 6)

3) SC 50 kg Grade II - JB, JC, J and J/2 were filled with 21 to 25 kg of TNT, amatol or trialen (p 7)

4) SC 250 kg - Types 1, 2, and 3, J, L, L2, B and K were filled with 287 lbs of amatol, TNT, TNT and wax or wood meal and Al powder and naphthalene and Am nitrate (p 8)

5) SC 500 kg Grade III (K, L2 and J) were filled with 220 kg of amatol, TNT or trialen. Bombs recovered with trialen filling contained also up to 500 cylindrical paper-wrapped pellets composed of RDX/Al/wax (p 9).

6) SC 1000 kg "Hermann" (C, L, and L2) were filled with about 600 kg of amatol, TNT/Al/wood meal or trialen (p 9)

7) SC 1200 kg was filled with 631 kg of trialen.

8) SC 1800 kg "Satan" was filled with amatol, TNT or trialen (p 11)

9) SC 2000 kg was filled with 975 kg amatol (p 12).

10) SC 2500 kg "MAX" was filled with trialen or a mixture of amatol with RDX and Al powder (p 13)

11) SB 400 kg Kugel K - "Kurt" Apparatus was filled with 300 kg high explosive. It was a "skip" bomb designed to operate like a skipping stone over a smooth water surface for use against ships, power plants, lock gates, etc. (pp 14-16)

12) SB 1000 kg was filled with 735 kg RDX/Al/wax biscuits in a Trialen 106 matrix (p 17)

13) SB 1000 kg Parachute was filled with biscuits consisting of Am nitrate 51, Ca nitrate 31 and RDX 16% in matrix of DNB 48, RDX 15, and Am nitrate 37% (p 17)

14) SB 2500 kg was filled with 2400 kg amatol or Trialen 105 (P 18)

15) SD 50 (D50, D50D and D50L) were filled with 16.4 kg TNT (p 19)

16) SD 250 kg (D250, D250JB, D250L and D250DL) were filled with 79 kg TNT (p 20)

17) SD 500 kg, SD 500 A and SD 500 E were filled with about 200 kg amatol or TNT/wax (p 22)

18) SD 1700 kg was filled with 730 kg of TNT or amatol (p 23)

19) PC 500 kg, D 500 E, and D 500 L were filled with about 75 kg of TNT, TNT/wax or amatol (p 24)

20) PC 1000 kg, ESAU was filled with 160 kg TNT/wax (p 24)

21) PC 1400 kg, FRITZ was filled with 300 kg of TNT/wax or trialen (p 25)

22) PC 1600 kg was filled with 230 kg RDX/Al/TNT mixture (p 26)

23) PC 400 kg RS was filled with 14 kg TNT (p 28)

24) PC 1000 kg RS was filled with 54 kg TNT (p 29)

25) PC 1800 kg RS was filled with 360 kg of TNT and trialen. One specimen had 3 blocks of NGu in the nose and 10 blocks of RDX/Al/wax in two cardboard cylinders in the body (p 30)

26) PD 500 kg was filled with 32 kg RDX/Al/wax in the body, associated with a nose filling block of NGu (p 31)

27) 0.5 kg A/P Parachute bomb contained 1 oz of an explosive (p 32)

28) 1 kg SD 1 Mortar contained cast TNT (p 33)

29) 1 kg SD1, FRZ contained amatol or granular TNT The FRZ was a French bomb used by the Germans (p 33)

30) 2 kg "Butterfly" SD 2A and SD 2B was filled with 7.5 oz of cast TNT surrounded by a layer of bituminous composition (p 34)

31) SB 3 kg contained 4 lbs of an explosive (p 35)

32) SD 4 kg HL (hollow charge) A/P and Vehicle contained 12 oz of cast TNT or 46/54 - TNT/RDX (p 36)

33) SD 10A Types I, II and SD 10 FRZ contained TNT or amatol (p 38)

34) SD 10C contained about 0.75 kg of an explosive (p 39)

35) 12 kg SC 10 Concrete contained 0.9 kg TNT (p 40)

36) SD 15 Converted Projectile contained hollow (shaped) charge explosive (p 40)

37) SBe 50 kg Concrete in earlier specimens contained TNT, and in all later Bombs a naphthalene explosive mixture of low brisance (p 42)

38) SBe 250 kg Concrete contained TNT pellets and a mixture of Am nitrate with small amounts of wood meal and Al powder (p 43)

39) SA 4000 kg contained biscuits of RDX/Al/wax in a matrix of 50/50 Amatol (p 43)

39a) BT (Bomben Torpedo), 200 kg, 400 kg, 700 kg and 1400 kg (p 44)

40) 2 kg Aircraft Towed Paravane was filled with a HE (p 46)

41). 1 kg, 1.3 kg, 2 kg and 2.2 kg Incendiary contained thermite as the incendiary and a HE as the burster charge (pp 46-50)

42) 50 kg Incendiary (Sprengbrand C 50) contained thermite as the incendiary and TNT as the burster charge (p 50)

43) 250 kg Incendiary (FLAM) contained an oil incendiary mixture and TNT as the burster charge (p 52)

44) 500 kg Incendiary (FLAM) contained a mixture of 70/30 - petroleum/benzene as the incendiary and TNT as the burster charge (p 54)

45) 50 kg Incendiary (Brand C 50 A) contained about 30 lbs of a mixture consisting of benzine 86, phosphorus 4 and pure rubber 10% (p 54)

46) 50 kg Incendiary (Brand C 50 B) contained about 77 lbs of white phosphorus (p 55)

47) 250 kg Incendiary (Brand C 250 A) Types I and II, contained a mixture of petroleum 87.7, polystyrene 11.7 and phosphorus 0.5% (p 56)

48) 50 kg Smoke (NC 50) contained a light grey smoke producing substance smelling strongly of camphor (p 58)

49) 50 kg Smoke Marker (NC 50 WC D/SEE) contained an unidentified smoke producing composition (p 58)

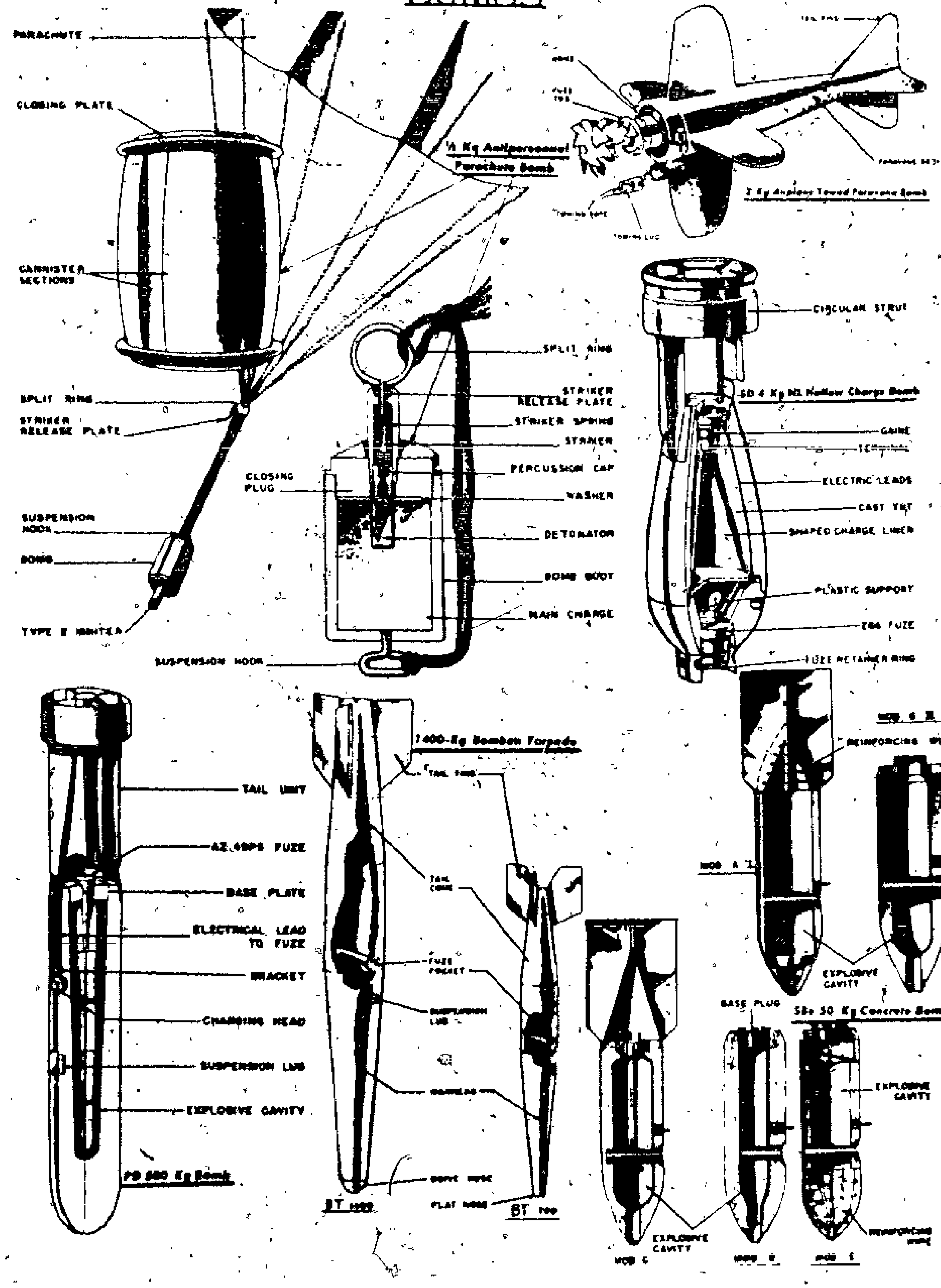
50) 250 kg Smoke (NC 250 S) contained a mixture of sulfur trioxide 60 and chlorosulfonic acid 40% (p 59)

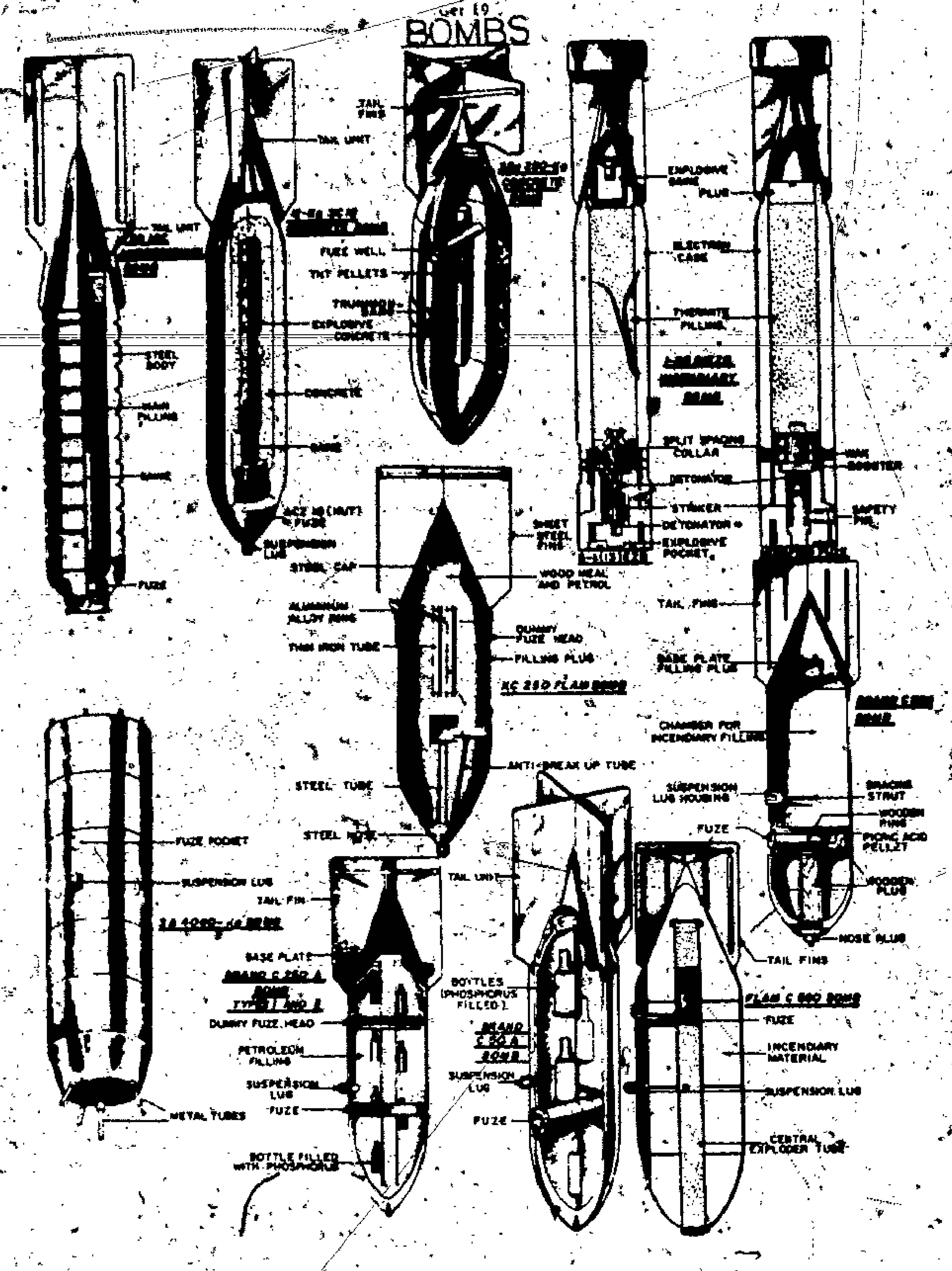
51) Practice Bombs: SD 1, SD 2, ZC 10 kg Concrete, ZC 50 kg Concrete, PC 1000 RS EX. and ZC 250 kg Concrete are described on pp 59-65 of TM 9-1985-2

52) Parachute Flares: LC 10 Single Candle, Fll 50 Single Candle, LC 50 F Ausf C Four Candles, LC 50 Ausf E, LC 50 F Ausf G, Mark C 50 FA, Mark 50 Kask Target Indicating, Mark 5 Types 1 & 2 and some others are described on pp 65-79

53) Smoke Flares Orange were used as wind drift

BOMBS





indicators (pp 79-80)
54) Smoke Signal Flares and Distress Signal Torch (pp 80-81)
55) Photographic Flash Bomb, BLC 50 (p 81)
56) Photoflash Bomb, BLC 50 (p 81)
57) Target Indicator, Red (p 84)
58) Marker Bomb (Sea) (p 85)
59) Sea Marker, "LUX EZ" 50 SC (p 86)
60) Single Unit Ground Marker, Mark 3, Green (p 87)
61) Parachute Recognition Smoke Generator (p 89)
62) "LUX N" (Flame Float) (p 92)
63) "LUX S" (Flame Float) (p 93)
64) Cluster Containers: BDE 10, AB 23 SD 2, AB 24T SD 2, AB 36, BSK 36, AB 42, AB 70 - 1 or Mark 70S, AB 70 - 3, AB 70 D 1, AB 250 - 1, AB 250 - 2, AB 250-3, AB 250 KZ, MK 250 LK, MK 250 BK, BSB 360, BSB 700, BSB 1000, AB 500 - 1, AB 500 - 3A, AB 500 - 1B, ABB 500, Mark 500 Boden and AB 1000 - 2 are described on pp 93-120 of TM 9-1985-2
65) Message Tubes (Sea and Land) (pp 120 - 1).

Abbreviations: A/P Antipersonnel, HE High explosive, HL Hohlladung (hollow charge), MK Mark, MNB Mononitrobenzene, NGu Nitroguanidine, RS Rocket-assisted, PC Armor-piercing, PD Armor-piercing, thick-walled, SA High capacity (HC), SBe Concrete fragmentation, SC General purpose (GP), SD Antipersonnel, ZC Cement cylindrical. (See also Abbreviations at the end of the German section).

References:

1) Technical Manual TM-E-9-1983 (1942), "Enemy Bombs and Fuzes"
2) "Deutsche Abwurfmunition", Berlin (1943)
3) Technical Manual TM 9-1985-2 (1953).

"Bombe BV-226" of Blohm and Voss was described on pp 99-100 of the book A. Ducrocq, Les Armes Secrètes Allemandes, Berger-Levrault, Paris (1947).

Bomb High Explosive Train. One of the German HE trains used during WW II in bombs consisted of the following parts:

A. **Electric primer.** A silver bridge wire with a bead, which consisted of a paste made of lead styphnate, collodion cotton and amyl acetate, dried after applying. In order to increase the flame produced on ignition of the bead by the red hot bridge, the bead was surrounded with 80/20 $KClO_3$/charcoal.

B. **Delay.** Composition for the delay element varied, depending on the desired delay time.

a) Delays up to 1 second contained black powder.
b) Delay 5 to 14 seconds consisted of $KClO_4$ 10, $PbCrO_4$ 50 and antimony 40%. As this mixture was difficult to ignite from the bead of the igniter, the following ignition mixture facilitated this operation: red lead 75, NC 5, carborundum 20%. In order to intensify the flame of the delay, the following booster composition was used $KClO_4$ 56, Pb ferrocyanide 38, resin 6%.
c) Delays up to 40 seconds contained $BaCrO_4$ 78.0, Zr 21.0, K_2CrO_4 0.4, NC 0.5, wax 0.1% and were used in conjunction with the ignition mixture and booster, as described under (b).

C. **Relay.** Two kinds were used; black powder, or the following mixture: $KClO_4$ 25-30, $Pb(SCN)_2$ 40-50, NC 20, sulfur 4-8%.

D. **Detonator** contained lead azide, sensitized with lead styphnate.

E. **Sub-booster** consisted of a layer of PETN over PETN-wax mixture contained in a cup, called the "gaine." The gaine was surrounded by a pressed P A ring with the remainder of the fuze pocket filled with pressed P A pellets to act as a booster.

F. Auxiliary booster consisted of pressed TNT pellets.

Note: Practically all German bombs contained an auxiliary booster, which was intended to assure the detonation even when using low grade explosives for charging bombs.

The following were the principal explosives used in German bombs: TNT, TNT-wax, Amatol, Ammonal, Cyclotol, Hexamite and Torpex.

[Allied and Enemy Explosives, Aberdeen Proving Ground, Md. (1946), pp 167-9].

Booster, Booster Charge, Gaine (Zündladung, Beiladung, Schlagladung, Anfeuerungssatz). The German booster was a cylindrical aluminum or brass container (gaine) filled with a HE (such as P A, PETN/wax or RDX/wax) and containing, inside the forward end, a detonator (filled with PETN or RDX and a priming layer of M F for boosters filled with P A or with L A/L St layer in other cases). The purpose of this detonator was to pick up the shock wave due to the explosion of the fuze detonator, to amplify the effect of the shock wave, and, in turn, to detonate the main booster charge. The powdered P A filling was in brass containers. The PETN/wax and RDX/wax fillings were in compressed form, tinted, respectively, pale pink and pale blue or blue-green.

The following Table 4 lists the booster charges examined during WW II at Picatinny Arsenal, Dover, New Jersey (Ref 2):

Table 4

Composition %	Uses
90/10- PETN/Wax	37 mm HE shell, 75 mm AP shell, 128 mm HE shell, 150 mm HE shell, 50 mm mortar bomb, HoC magnetic grenade, A/T rifle grenade, HoC rifle grenade and 210 mm HE rocket
89/11-PETN/Wax	75 mm HE shell, A/T rifle grenade
88/12-PETN/Wax	80 mm Mortar bomb
87/13-PETN/Wax	75 mm HoC shell, 80 mm HE mortar shell, 88 mm HE and HoC shell and 105 mm HoC shell
91/9-PETN/Wax	HC PAK 41 bomb, land mine
92/8-PETN/Wax	50 mm HE shell, 88 mm AP shell, 105 mm How shell
85/15-PETN/pressed TNT	47 mm AP shell
95/5-RDX/Wax	21 lb HoC demolition charge
96.5/3.5-RDX/Wax	88 mm AP shell
Tetryl (pre[illegible])	76.2 mm HE shell
TNT (cas[illegible]PET[illegible]wax core	75 mm AP shell
TNT (pre[illegible] about 1.45)	47 mm AP and HE shells, land mine
Pi[illegible] (pressed)	105 mm HE shell, 150 mm and 210 mm anti-concrete shells, hand grenades, Panzerwurfmine (A/T trench mortar shell)
40/60-Tetryl/TNT (pressed)	40 mm HE shell, A/T mine
Black powder	A/P mine

Abbreviations: AP Armor-piercing, A/P Antipersonnel, A/T Antitank, HoC Hollow(shaped) charge, HE High explosive, How Howitzer, L A Lead azide, L St Lead styphnate, M F Mercuric fulminate, Np S[illegible] as PETN, P A Picric acid, PAK Antitank, PETN Pentaerythritol tetranitrate, RDX Cyclonite (Hexogen).

The following types of boosters are described in Ref 1:
a) Booster A (Zdlg A) consisted of an Al cylinder 2.95" long and .83" in diameter, closed at one end and filled with a pressed RDX/wax-92/8% pellet, density 1.61 and weighing 577 grains. The pellet was tinted blue by the ad-

dition of a small quantity of dye. A cavity was formed at the forward end to receive the detonator which contained 6.5 grains of RDX under 6.3 grains of L A/L St-58.8/41.2% in an enclosed Al tube. A disc of Al with a central hole, held the detonator tube firmly in its cavity. The ensemble, held by a leather washer and an Al ring, completed the closure by being folded over the lip of the body

b) Booster B (Zdlg B) consisted of an Al cylinder 4.7" long and .87" in diameter, closed at one end and filled with three RDX/wax pressed pellets which were enclosed in two separate Al containers. The lower container had two RDX/wax-92/8% pellets, density 1.59, each weighing 232 grains. The container was sealed by spreading the lip over two Al discs. The upper container held a single pellet of RDX/wax (weighing 324 grains) and the detonator which contd 6.9 grains of RDX under 5 grains of L A/L St-68.6/31.4%. The container was closed by a perforated Al disc. The two containers were slid into the booster cylinder, and the whole assembly was retained in the booster body by a leather washer and an Al security ring, as in the Zdlg A.

c) Booster C/98Np (Zdlg C/98Np) consisted of an Al container filled with a PETN/wax pellet. There were two sizes: a small size, 1.6" long and .87" in diameter, designated "KzZdlg C/98" and a large size, 3" long and .87" in diameter, designated "GrZdlg C/98". The first was used in smoke shells and the second in HE shells.

There were also boosters: Zdlg C/98 (picric acid charge), grZdlg C/98Np (large C/98 Np booster), kzZdlg 34Np (short PETN charge booster), Zdlg 36 (PETN charge in bakelite container) and Zdlg 40 (PETN in cardboard container)

1) E.Englesberg, Ordnance Sergeant, May 1944, pp 319-20; 2) W.R.Tomlinson, Jr, Picatinny Arsenal Technical Report 1555 (1945), pp 9-16.

Bounding Mines. Same Type Mines as antipersonnel Land Mines, Schrapnellminen, such as S-Mi 35 and S-Mi 42, briefly described under Landminen.

Bounding Type Mortar Shell, 80 mm, HE. According to an examination conducted at Picatinny Arsenal (Ref 1), this shell was constructed as follows:

The content of the shell was, in general, of conventional mortar design, but the shell itself was in two parts, the division being at the forward edge of the bourrelet. In the nose (3) of the shell were assembled the German Mortar Shell Fuze Wgr Z 38 and the expulsion charge assembly (19). This was followed by the ignition tube (18), the detonator-booster assembly (4) and the HE filler (bursting charge). The base of the shell was provided with 12 fins of conventional design, an ignition cartridge and propellant increments. The body and fuze of the shell was 8 9/16" long and weighed 6.75 lbs when assembled. The length of the complete round (including the fin assembly) was 13.1" and the weight was 7.82 lb (See illustration on next page).

The shell was fired from mortar in the conventional manner but the functioning of the shell was different, as can be seen from the short description given below.

The impact of the fuze, or a sudden slowing up of the shell, resulted in the firing of the fuze primer. The flash from the primer ignited the igniter charge in the top of the expulsion charge assembly (19) in the forward end of the shell, and caused the burning of the propellant within the capsule. This separated the shell body and nose by shearing the set screws (16) which caused the body portion to be thrown upward or to bounce along the ground. A slight delay was possibly obtained by the gases from the expulsion charge (19) passing through the hole in the ignition tube (18), then expanding in the cavity below. An additional delay was obtained by means of the delay-detonator (12), the different elements in the delay-detonator being ignited in the order of their arrangement. Explosion of the detonator caused functioning of the booster pellet (11), which in turn caused the functioning of the burster charge of the shell.

This type of shell was particularly convenient for use over soft terrain such as swamplands. Where the shell would normally be buried prior to detonation, this design caused the shell, after deflection to burst in the air.

The compositions of the explosive components, as taken from Ref 2, are given below:

A) Ignition cartridge primer: a) upper charge: Ca silicide 59.4, red lead 24.7 and Ba nitrate 15.9%, weight 0.023 g, b) lower charge: Ba nitrate 47, Pb styphnate 33 and Ca silicide 20%; weight 0.034 g

B) Ignition cartridge propellant: NC (N content 13.1%) 58.3, NG 39.0, centralite 0.8, graphite 0.8, total volatiles 1.0 and unaccounted 0.7%; weight 10.0 g; squares about 0.0084" thick with length of side 0.0374"

C) Projectile fuze primer: K chlorate 51, Sb trisulfide 44 and Hg fulminate 5%; weight 0.022 g

D) Projectile expulsion charge assembly: a) igniter cup weighed 0.12 g and consisted of celluloid with N content 8.7%, b) igniter weighed 0.050 g and consisted of K perchlorate 50, Pb thiocyanate 45 and NC 5%, c) black powder pellet weighed 0.17 g and consisted of K nitrate 77.5, charcoal 12.7 and sulfur 9.8%, d) expulsion propellant capsule weighed 3.1 g and consisted of celluloid with N content 8.7% e) expulsion propellant charge weighed 12.5 g and consisted of NC (N content 13.0%) 93.9, centralite 2.6, graphite 1.0; total volatiles 1.2, diphenylamine 0.3 and unaccounted 1.0%; form cords 0.0352" long and 0.0469" diameter

E) Delay-detonator-booster assembly: a) washer consisted of phenol-formaldehyde impregnated paper, b) delay-detonator consisted of 0.10 g upper charge: red lead 74.7, silicon 17.8 and binder, of which there was 5.1% of "A" stage phenol-formaldehyde condensation product and 2.4% of "B" stage product, c) lower charge consisted of 0.225 g of Pb chromate 50.2, K perchlorate 24.5, silicon 24.5 and binder 0.8%, d) disc separating delay from detonator consisted of 0.038 g NC 70 and NG 30%, e) detonator consisted of 0.35 g upper charge Pb azide 50, Pb styphnate 30, PETN 10% and 0.25 g PETN as lower charge

F) Bursting charge of the shell consisted of about 380 g of TNT or of 65/35 Amatol (Am nitrate 65, TNT 35%).

G) A disc (15) serving as a gas check and consisting of 4.2 g Mg oxychloride, was placed at the bottom of the bursting charge.

References:

1) J.P.Wardlow, Pic Arsn Tech Rept 1422 (1944)

2) E.F.Reese et al, Pic Arsn Chem Lab Rept 104 912 (1944).

"B" Pulver-See Blättchenpulver

Brandbombe. An incendiary bomb containing white phosphorus either alone or in mixtures with highly combustible materials. The following types are described in TM 9-1985-2 (1953), pp 54-7:

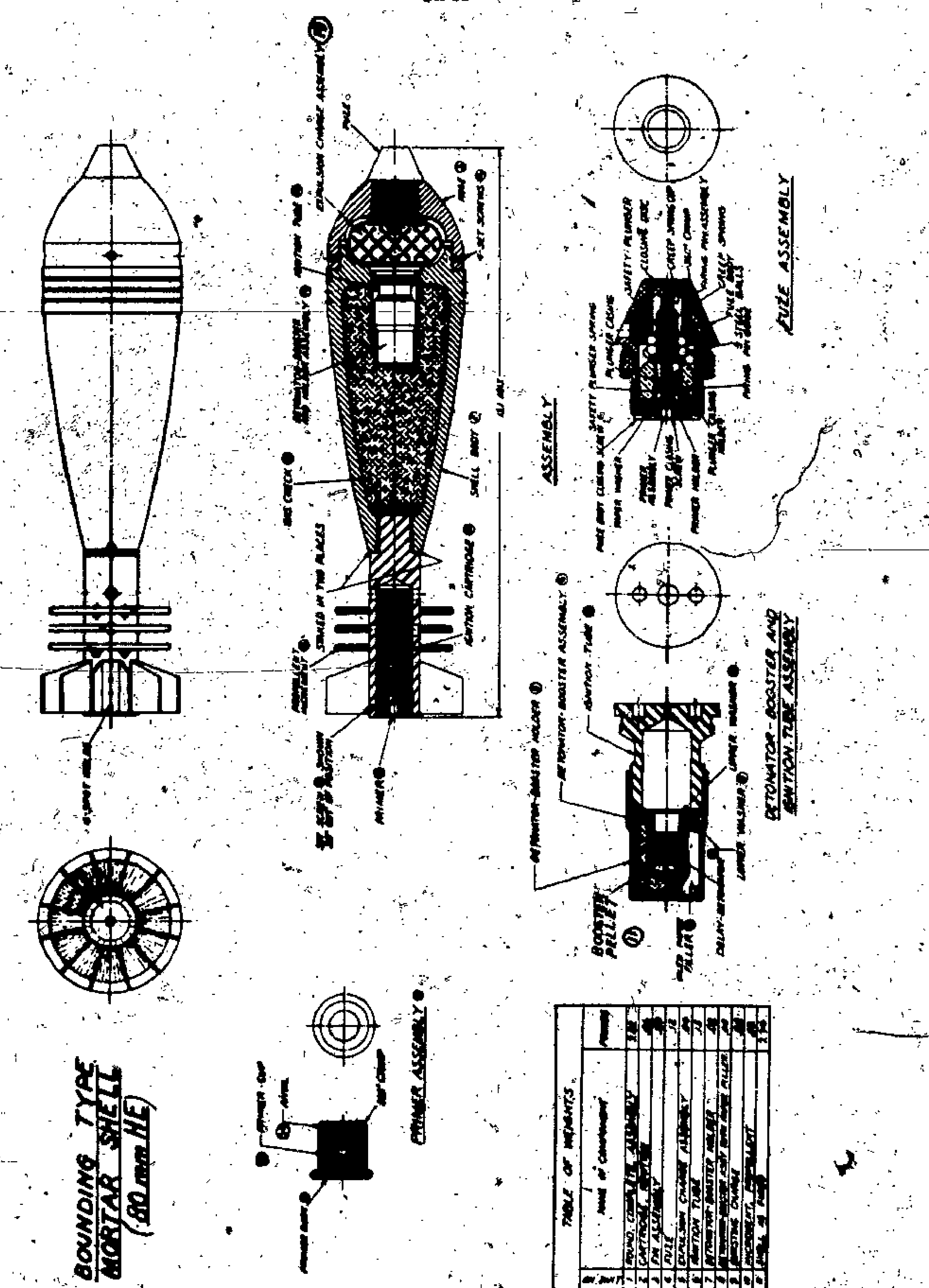
a) Brand C50A contained approx 30 lb of a mixture consisting of phosphorus 4, benzine 86, and pure rubber 10% (p 54)

b) Brand C50B contained white phosphorus (p 55)

c) Brand 250A, Types I and II contained the following mixture: petroleum 87.7, polystyrene 11.7 and phosphorus 0.5% (p 56).

(See also under Flammbomben, Incendiary Bombs and Sprengbrandbomben).

Brandkissen (Self-igniting Cushion) consisted of a 2" x 2" rubber-impregnated cheese-cloth pillow case filled with capsules containing aluminum-chloromethyl mixture (Methyl



Stoff). A number of such cushions was placed on the runway of a landing field. It was hoped that on landing the pressure of the wheels of the enemy's plane on the cushions would crush some of the capsules. The liberated Al chloromethyl would then ignite on contact with the air and destroy the tires and possibly the plane. In practice the idea was unsuccessful as ignition was too slow and the high landing speed of the planes usually carried them safely beyond the ignited cushions.
Reference: CIOS Rept 25-18 (1945), p 25.

Brandsätze und Brandbomben. See Incendiary Compositions and Incendiary Bombs.

Brank (von Brank) in 1891-1892 patented several compositions suitable for use as propellants in small arms, such as: a) K chlorate 59.52, K bichromate 34.53, carnauba wax 5.95%, b) K chlorate 86.96, resin 13.04% [Daniel, Dictionnaire (1902), p 790].

Brennstoff und SV-Stoff. See SV-Stoff und Brennstoff.

Brennzünder (Friction Type Igniter). See under Igniter.

Brenzkatechin. See Pyrocatechol in the general section. Was used by Germans as an ingredient of liquid propellants, usually in combination with Visol 6 (vinylethylether), aniline etc. Methods of analysis of such mixtures are given in I G Farbenind A -G Report, Archiv Nr 110/20 g, Methoden zur Untersuchung von Brenzkatechin-Brennstoffen mit Visol 6, 20 March (1944).

Brisanz (Brisance). See in the general section.

Brisanzmesser (Apparatus for Measuring Brisance) See under Brisance Tests in the general section.

Brisanzplattenbeschuss (Literally Brisance Plate Shooting). The plate test for brisance was conducted by exploding a charge of an explosive on the surface of a metallic plate (such as of lead, steel, or aluminum). The extent of the damage produced was compared with that caused by the same weight of a standard explosive, such as TNT. The tests are briefly described in the general section and also in A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948) pp 110-111.

Brisanzwert (B) (Brisance Value) is calculated by the method developed by Kast, as described in the general section.

Brisanz Kapsel (Brisanz Detonator). According to Stettbacher (Ref 1), Brisanz Kapsel No 8 contained a primary charge 0.30 g of 4/6 mixt L A/L St (compressed at 400-500 atm) and the base charge 0.85 g tetryl, compressed at 2000 atm. Médard (Ref 2) gives for Brisanz detonator 0.32 g of L A/L St mixture and 0.70 g of tetryl. The detonator case was made of aluminum because copper and brass are attacked by L A.
References:
1) A.Stettbacher, Schiess- und Sprengstoffe, J.A.Barth, Leipzig (1933) p 348
2) L.Médard, Mém poud 33, 339 (1951).

Brückenzünder (Bridge-wire Cap of Electric Blasting Cap). Various systems of German electric caps using resistance bridge-wire are described in Beyling-Drekopf, Sprengstoffe und Zündmittel, Springer, Berlin, (1936) pp 179-216.

Brummbär (Grizzly Bear). A self-propelled mount consisting of 150 mm howitzer or heavy infantry gun on PzKpfw IV (See also under Panzer).

"B" Stabmine. See under Landminen and also on pp 276-7 of TM 9-1985-2 (1953).

B-Stoff (LB-Stoff). A mixture consisting of hydrazine hydrate 92 and water 8%. Sp gr 1.032 at 20°. When mixed with T-Stoff (hydrogen peroxide) and K cuprocyanide (as a catalyst), the liquid ignites spontaneously. Since the heat of combustion of hydrazine hydrate is very low a new mixture known as C-Stoff was proposed (CIOS 30-115, pp 8 & 10). (See also C-Stoff, M-Stoff and T-Stoff).

"Buch" (Zünder). Chemical, crush-actuated type igniter. It is briefly described under Igniter.

Bullet (Geschoss oder Kugel). See Small Arms Ammunition.

Bumble Bee. See Hummel.

Bursting Charge (Sprengladung, Sprengstoffgehalt, Sprengsatz). Table 5, given on next two pages, lists German bursting charges described in Picatinny Arsenal Tech Rept 1555, pp 3-8.

"Busy Lizzie". See under High Pressure Pump.

1, 2, 4 - Butantrioltrinitrate. See general section under Butanetriol. According to Stickland et al, PB Rept 925 (1945), p 15, the substance was tried by the Germans during WWII as an explosive plasticizer for NC to replace NG, but apparently it was not adopted. Its properties were reported as follows: stable, less volatile than NG, calorific value 1440 cal/g with H_2O in liquid phase. It proved to be only a medium good gelatinizer for NC.

C-2. Same as Wasserfall (Waterfall Guided Missile) [TM 9-1985-2 (1953), pp 219-23].

"C6". A mixture developed in Germany during WWII as one of the substitutes for TNT: Mon-Salz 50, $NaNO_3$ 35 and RDX 15%. Its density of fragments was 39 m (TNT 40 m). It was suitable for loading shells and bombs [G.Römer, PBL Rept No 85,160 (1946) p 25].

Cahücit (Cahoesite). A type of blasting explosive such as: a) K nitrate 70, wood meal 10, charcoal 8 and sulfur 12% (Ref 1); b) K nitrate 64.0, lampblack 7.0, sulfur 12.0 and wood pulp 17.0% and iron sulfate added 1.5% (Ref 2). These explosives were manufactured by the Deutsche Cahücit Werke A -G, Gnaschwitz. (See also Wetterammoncahücit under Wettersprengstoffe)
References:
1) Ullmann, Enzyklopädie, v 4 (1929), p780
2) Thorpe's Dictionary, v 4 (1940), p 463.

Calcinit (Calcinite). A type of mining explosive contg large amounts of technical calcium nitrate [$Ca(NO_3)_2 \cdot 4H_2O$], such as:

Calcinit 1. NG 15-20, Ca nitrate 32-36, Am nitrate 32-34, wood meal 13-17, liquid hydrocarbon (with flash point not lower than 30°) 0-2% (Ref 2).

Calcinit 2. NG 15-20, Ca nitrate 60-70, Am nitrate 0-15, charcoal and/or vegetable meal 6-15, liquid hydrocarbon (with flash point not less than 30°) 0-8% (Ref 2)

Marshall (Ref 1) gives for a Calcinite: NG 20, Ca nitrate 66 and charcoal 14%. Stickland (Ref 3) gives for Calcinit 1 manufactured at the Krümmel Fabrik of D A -G the following composition: NGc (nitroglycol) 6.0, DNT 4.8, TNT 7.2, Ca nitrate (tech) 38.0, Am nitrate 35.5, wood meal 8.0, caput mortuum dye (Fe_2O_3) 0.5%.
References:
1) Marshall, Explosives, v 3 (1932), p 109
2) Beyling-Drekopf, Sprengstoffe (1936), p 99
3) Stickland, PB Rept 925 (1945), p 69.

Table 5.
Bursting Charges

Charge	Uses
TNT (pressed)	37 mm HE shell with PETN as a detonator base charge, 40 mm HE shell with 40/60-tetryl/pressed TNT booster, 47 mm AP shell with 85/15-PETN/pressed TNT booster and 150 mm HoC (shaped charge) rocket
TNT (cast)	37 mm HE shell with PETN/wax booster, 47 mm AP or HE shells with pressed TNT boosters and 50 mm HE shell with PETN/wax booster; 50 mm Trench Mortar shell with 92/8-PETN/wax booster, 75 mm AP and HE shells with PETN/wax boosters; 76.2 mm AP shell with PETN/wax booster } Used in captured 76.2 mm HE shell with tetryl booster } Russian guns 80 mm HE shell with PETN/wax or pressed TNT booster, 88 mm HE shell and 105 mm AP shell and 105 mm HE shell with pressed P A or PETN/wax boosters; 105 mm How shell with 92/8-PETN/wax booster, 150 mm HE shell with PETN/wax booster, 150 mm and 210 mm A/C shells with PETN/wax boosters, 170 mm and 203 mm HE shells with PETN/wax boosters, 210 mm A/C and HE shells with PETN/wax boosters and 240 mm and 280 mm HE shells with PETN/wax boosters; 500 kg and 1000 kg AP bombs; 1 kg, 2 kg, 10 kg, 250 kg and 500 kg Frag bombs and 10 kg, 50 kg, 250 kg, 500 kg, 1000 kg and 1800 kg GP bombs; 50 kg HE Inc bomb, Butterfly bomb and 50 kg A/C bomb, 50 mm, 80 mm and 105 mm Mortar shells; 27.5 lb and 110 lb Demolition charges, Egg and Stick hand grenades, Panzerwurfmine, A/P and A/T mines, and A/T and HoC rifle grenades
85/15-TNT/wax	500 kg Frag bomb
TNT with 5-10% wax	88 mm AP shell with 92/8-PETN/wax booster, 47 mm HE shell and 150 mm A/C shell with P A booster, 900 kg, 1000 kg and 1400 kg bombs
90/10-TNT/Al	250 kg GP bomb and 75 mm HE Inc shell
Picric acid (pressed)	75 mm HE shell with PETN/wax booster
EDDN (Ethylenediamine dinitrate)	105 mm AP shell with RDX/wax booster
RDX (Hexogen)	42 mm HE shell
88/12-PETN/wax	20 mm AP and HE shells with PETN detonator base charges, 28/20 mm HE shell and A/T rifle grenade
82/18-PETN/wax	37 mm AP shell
87/13-PETN/wax	50 mm AP shell with PETN/wax booster
85/15-PETN/wax	20 mm HE shell and 37 mm AP shell
90/10-PETN/wax	27 mm and 37 mm HE shells with PETN detonator base charges and 40 mm HE shell with 40/60-tetryl/pressed TNT booster
91.5/8.5-PETN/wax	20 mm HE shell, 50 mm AP shell, 80 mm Chem Mortar shell
PETN/wax/Al	20 mm HE Inc shell
90/10-RDX/wax	75 mm AP shell with 94/6-PETN/wax detonator base charge and 88 mm AP shell with RDX or 96.5/3.5-RDX/wax detonator base charge
94/6-RDX/wax	75 mm HoC shell with 90/10-PETN/wax booster
EDDN/RDX	105 mm AP shell with RDX/wax booster
33/3/64-RDX/wax/Zn	20 mm HE Inc shell with PETN detonator base charge
75/1/19/5-RDX/wax/powd Al/solid Al ring pellet	20 mm HE Inc shell with PETN detonator base charge
30/70-PETN/TNT (pressed)	37 mm AP shell with PETN detonator base charge
30/70-PETN/TNT (cast)	37 mm AP shell
62/35.5/2.5-RDX/TNT/wax (pressed)	37 mm HoC shell with 90/10-PETN/wax booster
57.5/40/2.5-RDX/TNT/wax	75 mm HoC shell with 89/11-PETN/wax booster
57/40/3-RDX/TNT/wax	105 mm HoC shell with PETN/wax booster
51/48/1-RDX/TNT/wax	75 mm HE shell
48.5/48.5/3-RDX/TNT/wax	150 mm HoC shell with 90/10-PETN/wax booster
TNT/KCl/wax	210 mm A/C shell with P A booster
76/4/20-RDX/wax/Al with NGu nose pad	1800 kg AP bomb

Table 5 (cont)

40/60-Amatol	75 mm HE shell with PETN/wax booster; 76.2 mm HE, 80 mm, 88 mm, 105 mm, 120 mm, 128 mm, 150 mm and 210 mm shells; 210 mm and 300 mm Rockets; Panzerfaust with 90/10-PETN/wax booster
35/65-Amatol	75 mm HE shell with 94/6-PETN/wax booster; 80 mm mortar shell and land mine
65/35-Amatol	200 mm Mortar shell with PETN/wax booster
30/70-Amatol	75 mm HE shell with 89/11-PETN/wax booster
60/40-Amatol	88 mm HE shell with 87/13-PETN/wax booster and 500 kg AP bomb; 1 kg, 2 kg, 50 kg and 500 kg Frag bombs; 50 kg, 250 kg, 1000 kg, 1700 kg, 1800 kg and 2000 kg GP bombs
50/50-Amatol	50 kg, 250 kg and 500 kg GP bombs; A/T mine, land mine, wood land mine and 80 mm Mortar shell
45/55-Amatol	Land mine
80/20-Amatol	Egg hand grenade, rifle grenade
Trialen (15/70/15 RDX/TNT/Al)	1400 kg and 1800 kg AP bombs; 250 kg, 500 kg, 1000 kg, 1200 kg, 1800 kg and 2500 kg GP bombs
90/5/2.5/2.5/-NH_4NO_3/$C_{10}H_8$/wood-meal/Al	50 kg A/C bomb, 250 kg GP bomb
35/50/15-NH_4NO_3/DNB/RDX	70 kg Frag bomb and 250 kg GP bomb
35/50/15-NH_4NO_3/DNB/RDX, with nose filling of 53/30/17-NH_4NO_3/Ca nitrate/RDX and TNT top off	500 kg Frag bomb, 50 kg GP bomb, 250 kg GP bomb and 1000 kg Parachute bomb
RDX/Comp B2	1000 kg Bomb
70/20/10-NH_4NO_3/TNT/Al	PAK 44 bomb with 90/10-PETN/wax booster
50/50-RDX/TNT	33.5 kg Demolition charge, Panzerwurfmine, Magnetic grenade and rifle grenade
60/40-RDX/TNT	Panzerfaust with PETN/wax booster
69/17/11/3-NC/NG/wax/Mg salts	Land mines
TNT/DNAniline	Rifle grenades
Hexanite/TNT/Al	Sea mines

Abbreviations: AA Antiaircraft; A/C Anticoncrete; AP Armor-piercing; A/P antipersonnel; A/T Antitank; GP General purpose; HE High-explosive; HoC Hollow charge; How Howitzer; NGu Nitroguanidine; P A Picric acid; PETN Pentaerythritol tetranitrate; Inc Incendiary; Comp Composition; Frag Fragmentation.
Note: According to M. Giua et al, Dizionario di Chimica, UT-ET, Torino, v2 (1949), p 166 some German hand grenades were filled with a mixture of black powder 83, K perchlorate 12 and Al (powder) 5%.

Calciumkarbonat (Calcium Carbonate). See general section.

Calciumnitrat (Calcium Nitrate). See general section, under Nitrates.

Calciumsilizid (Calcium Silicide). See general section.

Calorific Value of a propellant was determined by firing a charge of 1.2 g in a calorimeter bomb of 12 cc capacity, the charge being ignited by means of a hot wire and a piece of uncolloided gun-cotton. The values obtained by this method were higher than those obtained by calculation. Reference: CIOS 31-68, p 8.

Cannon. See Kanone and under Weapons.

Carbonit (Carbonite). A type of permissible explosive which may be considered as a straight dynamite with the temperatures of explosion lowered by the excess of carbon it contains. As a class, carbonites merge through the ammon-carbonites with the ammonium nitrate class of explosives.

The first carbonite appeared in 1885 (Bichel and Schmidt inventors) and since then the carbonites have been modified several times. The composition which passed the Woolwich Test in England contained, according to Marshall (Ref 1): NG 26, K and Ba nitrate 33, wood meal 40.5, sulfuretted benzene 0.25, Ca and Na carbonate 0.25%.

The composition of four German carbonites used after WW I given in Table 6 were described by Naoúm (Ref 2) and Davis (Ref 3).

(See Table 6 on next page).

(See also Kohlen-Carbonit under Kohlen-Sprengstoffe and Extra-Carbonit).

References:
1) Marshall, 1 (1917) pp 375 & 492 2) Naoúm, Nitroglycerin, Baltimore (1928), pp 401-2 3) Davis (1943), pp 352-353.

Cartridge (Patrone in fixed ammunition; Kartusche in semi-fixed ammunition); Cartridge Case (Patronenhülse; Kartuschhülse). German cartridge cases for small arms ammunition were of conventional design and drawn either from sheet brass (Cu 72, Zn 28%) or from sheet steel, copper-plated on both sides (Ref 1, p 357). German artillery cartridge cases of pre-WW II were made of brass but since 1942 the majority of cases were made of sheet steel, copper-plated on both sides. Later in the war the so-called wrapped steel cartridges were produced. Cartridge cases were employed in all German artillery ammunition (fixed and semi-fixed) and there was no ammunition corresponding to the American "separate-loading". The case was chiefly employed to reinforce the breech block and to seal the gases generated by the propellant. Although in fixed ammunition the cartridge case served the purpose of protecting the propellant charge, in many of the semi-fixed rounds the propellant charge was larger than the cartridge case and therefore the case did not give complete protection to the charge (Ref 2)

Table 6
Carbonites

Composition (%) and properties	Carbonit	Carbonit I	Carbonit II	Carbonit Extra
NG	25.0	25.0	30.0	35.0
Collodion cotton	-	-	-	0.3
K nitrate	30.5	-	-	25.5
Na nitrate	-	30.5	24.5	-
Ba nitrate	4.0	-	-	4
Spent tan bark	40.0	-	-	-
Meal	-	39.5	40.5	34.7 (tan meal)
K bichromate	-	5.0	5.0	-
Na carbonate	0.5	-	-	0.5
Density	-	-	1.10	1.20
Heat of Explosion, kcal/kg	576	536	602	-
Temperature of Explosion, °C	1874	1666	1639	-
Velocity of Detonation, m/sec	2463	3042	3850	4070
Trauzl Test (10g sample)	235 cc	240 cc	250 cc	-

The following cartridges, both German and captured from conquered countries, are briefly described in Ref 3:

A. Fixed Artillery Ammunition include:
a) 20 mm Mauser and Oerlikon; used on various 2 cm guns and some machine guns
b) 30 mm; used in 3 cm Solothurn Aircraft Cannon
c) 37 mm; used in 3.7 cm Pak, 3.7 cm Flak, 3.7 C/30 (Naval) and 3.7 cm Polish Pak guns
d) 40 mm; used in 4.0 cm Flak 28
e) 47 mm; used in 4.7 cm Czech and 4.7 cm Austrian Böhler guns
f) 50 mm; used in 5 cm Pak and 5 cm KwK 38 guns
g) 75 mm; used in various 7.5 cm guns
h) 76.2 mm; used in captured Russian 7.62 cm guns
i) 76.5 mm; used in 7.65 cm captured Austrian, Czech and Yugoslav guns
j) 88 mm; used in 8.8 cm Flak 18, Flak 36, Flak 37 and Flak 41 as well as various 8.8 cm Pak guns.
k) 100 mm; used in 10 cm K 17, and K 18 guns and various 10 cm lFH

B. Semifixed Ammunition includes:
a) 75 mm; used in 7.5 cm FK and 7.5 cm FH
b) 105 mm; used in 10 cm K17, K18 and various FH
c) 122 mm; used in some 12.2 cm captured Russian guns
d) 128 mm; used in 12.8 cm Flak 40 and Pak 44 guns
e) 150 mm; used in 15 cm K18, K39, sFH13, sFH 18 and other weapons
f) 152 mm; used in 15.2 cm captured Russian guns
g) 155 mm; used in 15.5 cm captured French and Polish guns
h) 170 mm; used in 17cm KiMrs Laf
i) 194 mm; used 19.4 cm French Railway Gun
j) 203 mm: used in 20 cm K(E)
k) 210 mm; used in 21 cm Mrs 18 and lgMrs 18
l) 240 mm; used in 24 cm Th BrK(E) and Czech sK
m) 280 mm; used in K5(E) and other guns
n) 353 mm; used in 35.3 cm HMl

C. Small Arms Ammunition includes:
a) 6.35 mm pistol cartridges
b) 7.65 mm pistol cartridges
c) 7.92 mm rifle and machine gun cartridges
d) 9 mm machine gun cartridges
e) 13 mm Solothurn cartridge
f) 15 mm Mauser cartridge

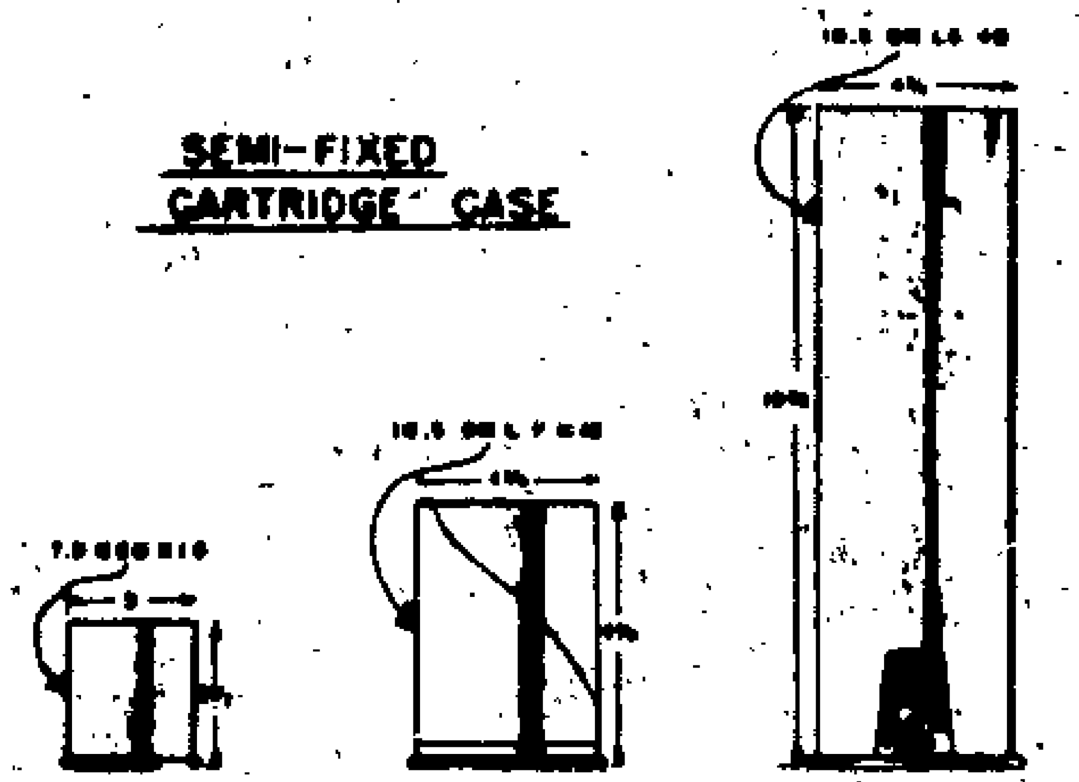
Note: Some of the 13 mm and 15 mm ammunition have sometimes been considered as artillery ammunition

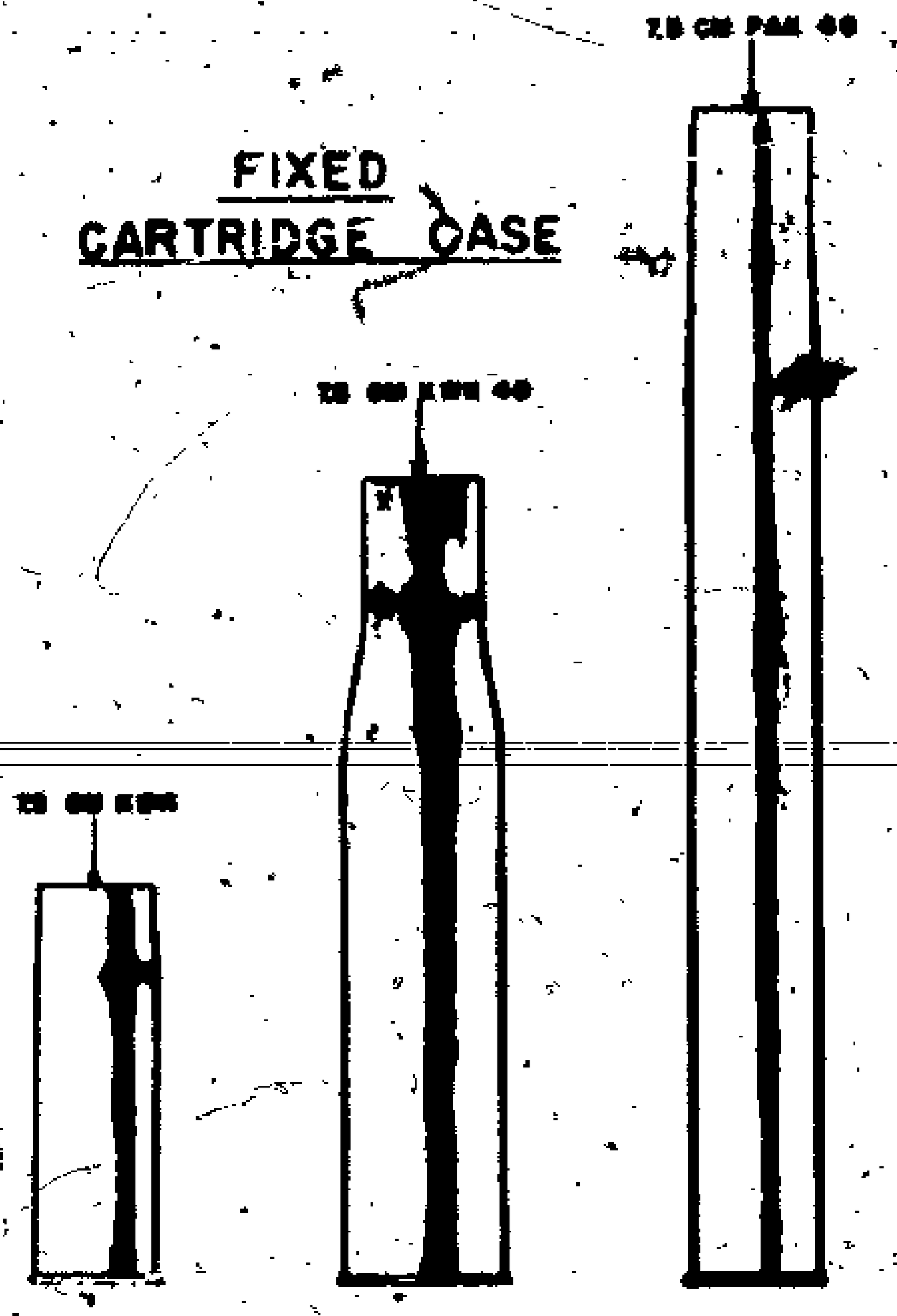
Designations: C Construction (Pattern); (E) Eisenbahn (Railroad); F Feld (Field); FH Feldhaubitze (Field Howitzer); FK Feldkanone (Field Cannon); Flak Antiaircraft; H Haubitze (Howitzer); K Kanone (Cannon); K(E) Kanone Eisenbahn (Railroad Gun); KiMrsLaf Kanone ins Mörser Lafette (Gun in Mortar Mounting); KK Kasemattenkanone (Casemate Gun); KwK Kampfwagenkanone (Tank Gun); l leicht (light); lg lang (long); lFH light Field Howitzer; lgMrs Long Mortar; M Mark or Model; Mrs Mörser (Mortar); Pak Antitank; s schwer (heavy); sK Heavy Gun; ThBrK(E) Theodor Bruno Kanone, Eisenbahn (Theodor Bruno Gun, Railroad).

(See also Ammunition, Bullet, Granate, Small Arms Ammunition and Steel Ammunition).

(References are given on the next page).

SEMI-FIXED CARTRIDGE CASE





References:
1) A.J.Dere, Ordnance Sergeant, Dec 1943, pp 357-61
2) E.Eaglesberg, Ordnance Sergeant, May 1944, pp 321-2
3) Anon, Technical Manual TM 9-1985-3 (1953), pp 540-44.

Cartridge Cap Compositions examined at Picatinny Arsenal and listed in the Pic Arsn Tech Rept 1555 (1945) p 30 are as follows:

a) M F 52, K chlorate 23, Sb trisulfide 20, abrasive 5%
b) M F 25, K Chlorate 37, Sb trisulfide 30, glass 8%.

Cartridge Case Percussion Primer (Low Explosive Train or Propellant Train)(Zündpatronensatz). The compositions in Table 7 were taken from Picatinny Arsenal Technical Report 1555, p 15.

Cartridge Cases, Steel (Patronenhülse Stahl). Due to the shortage of copper many types of German cartridge cases were made of steel. Brief descriptions of their methods of manufacture are given in the following CIOS Reports: 26-74, 27-36, 31-53 and 31-54.

Cascade Flare Bomb (Mark 50 Kaskade) is briefly described under Pyrotechnic Anti-Pathfinder Devices.

Celludol (Celludin or Camphrocel). See Plastol.

Centralit (Centralite) is a type of organic derivative of N,N'-diphenylurea developed beginning in 1906 at the Centralstelle für wissenschaftlich-technische Untersuchungen zu Neubabelsberg. Following are compounds suitable for use as stabilizers:

Centralit I (Mollit I) (Ethyl centralite). N,N'-Diethyl N,N'-diphenyl-urea.

Centralit II (Mollit II) (Methyl centralite) N,N'-Dimethyl-N,N'-diphenyl-urea.

Centralit III (Methylethyl centralite) N-Methyl-N'-ethyl-N,N'-diphenyl-urea.

All three centralites are described in the general section. The first two compounds were used in Germany and other countries primarily as stabilizers for propellants. When used in amounts exceeding the requirements for a stabilizer (such as above, about 1%), centralites act also as gelatinizers for NC and probably, at least in part, as flash reducers

(See also under Propellants).

References:
1) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), p 197
2) Kast-Metz, Chemische Untersuchung, Vieweg, Braunschweig (1944), p 165.

Table 7

Cartridge Case Percussion Primer Compositions.

Composition %	Uses
48/52-Ba nitrate/L St	7.92/13 mm HE shell
35/37.5/21.5/6.5-$KClO_3$/Sb_2S_3/M F /abrasive	20 mm AP Inert Chge shell, 20 mm HE shell, 50 mm AP & AP HV shell, 88 mm HE and Mech time fuze shell
43/24/24/9-$KClO_3$/Sb_2S_3/M F / abrasive	37 mm AP and HE shells and 105 mm HE Howitzer shell
30/24/35/11-M F /$KClO_3$/Sb_2S_3/glass	37 mm HE shell
28/31/26/15-$KClO_3$/Sb_2S_3/M F/abrasive	47 mm AP,AP HV and HE shells
89/11-L St /NC lacquer	50 mm AP,AP HV and HE shells and 75 mm AP and HE shells
28/34/32/6-M F /$KClO_3$/Sb_2S_3/ glass	50 mm HE shell
22/40/38-M F /$KClO_3$/Sb_2S_3	76.2 mm AP shell
Pb picrate/NC/charcoal/KNO_3	150 mm and 210 mm Rockets (Wurfgranaten)

Abbreviations: AP Armor-piercing; HE High-explosive; HV Hyper-velocity; L A Lead azide; L St Lead styphnate; M F Mercuric fulminate; NC Nitrocellulose; Chge charge; Mech Mechanical.
(See also Primers).

Centralstelle für, etc. See Zentralstelle für wissensch-techn Untersuchungen.

Centrifugal Casting of Gun Barrels is described in CIOS Repts: 29-39 and 31-46.

Cheddit (Cheddite). Chlorate and perchlorate explosives invented in France but also used in Germany and other countries (see under French Explosives and in the general section).

Chemical Warfare (Chemischer Krieg, Gaskampf, Gaskrieg) and Chemical Warfare Agent (Chemischer Kampfstoff). Although the Germans did not use any of the poison gases or liquids during WW II, as they did during WW I, quite a number of such substances, and some of them extremely toxic, were prepd and were ready for use. The most dangerous among them were the Trilons (q v).

E.W.Bateman, in, CIOS Rept 32-13 (1945), pp 20-2, describes several Chemical Warfare Weapons manufd by the Maschinen Fabrik Peterson, Oldenburg. Some of the weapons were filled with toxic mixtures based on DM (Adamsite), as for instance: DM 43.2, Am perchlorate 28.5 and urea resin syrup 28.3%. This mixture was initially liquid but became solid 2 hours after being prepared. Another mixture known as A-Pulver consisted of DM, NC and diphenylamine in various proportions. Several other mixtures, such as APM 30, APM 49 and Q 192 are mentioned by Bateman, but the compositions are not given.

Chemische Beständigkeitsproben (Chemical Stability Tests). Various tests used for explosives and propellants are described in the book of Kast-Metz, Chemische Untersuchung der Spreng- und Zündstoffe, Vieweg, Braunschweig (1944) and also in the general section.

Chemischer Zünder "Buck". See Chemical Igniter under Igniter

Chemisch-mechanischer Zünder. See Chemical-Mechanical Igniter under Igniter.

Chemisch-Technische Reichsanstalt(CTR), vormals Militärversuchsamt(Government Chemical-Technical Institution, formerly Office of Military Research). A scientific institution located in Berlin and devoted to problems of the Armed Forces (Wehrmacht). Its work included research on ammunition, explosives, liquid fuel, military equipment etc. The Reichsanstalt, before WW II, published the journal called Jahresbericht der Chemisch-technischen Reichsanstalt.

Reference: Dr H.W.Adam, Picatinny Arsenal; Private communication (1954).

Chlorate Explosives. See Chloratsprengstoffe.

Chloratit (Chloratite). A type of chlorate blasting explosive, such as listed in the Table 8

Table 8

Components and some properties	Chloratit 1	Chloratit 2	Chloratit 3
Na chlorate and/or K chlorate	70-72	73-75	83-91
Vegetable meal	1-2	1-2	0-4
TNT and DNT	18-20	18-20	-
Paraffin	3-4	3-4	-
Nitroglycerin	3-4	-	-
Liquid hydrocarbons (flash point not less than 30°)	-	-	5-12
Oxygen Balance	+3.0%	+1.9%	-
Lead Block Expansion	290 cc	280 cc	-
Lead Block Crushing	20 mm	19.5 mm	-
Sensitivity to Initiation (requires at least)	No 5 Cap	No 1 Cap	-
Gap Test (using 25 mm cartridges)	8 cm	8 cm	-
Velocity of Detonation	5000 m/sec	4300 m/sec	-
Density of Charge	1.57	1.46	-
Heat of Explosion	1250 cal/g	1280 cal/g	-
Temperature of Explosion	3645°	3700°	-

Note: One of the chloratites 1 was called Gesteins-Koronit T 1, one of the chloratites 2 was called Gesteins-Koronit T 2 and one of the chloratites 3 was called Miedziankit.

References:
1) P.Naoúm, Schiess- und Sprengstoffe (1927), p 151
2) Marshall, 3 (1932), p 112 3) A.Stettbacher (1933), p 314
4) Beyling-Drekopf (1936), p 97 5) F.Weichelt, Handbuch der gewerblichen Sprengtechnik, C.Margold, Halle/Saale (1953), p 35.

Chloratsprengstoffe (Chlorate Explosives). Mixtures based on chlorates, such as Chloratit, Gesteins-Albit, Gesteins-Koronit and Miedziankit.

The chlorate explosives were invented in France and used under the name of Cheddites.

References:
1) R.Escales, Chloratsprengstoffe, Veit, Leipzig (1910)
2) P.Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), pp 124-132
3) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), pp 309-315
4) C.Beyling-K.Drekopf, Sprengstoffe und Zündmittel, Springer, Berlin (1936), p 96
5) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 90-1.

Chlorobromomethane. See Feuerlöschmittel CB.

Chrom-Ammonit (Chrome-ammonite). A type of coal mining explosive used before WW I: a) Am nitrate 70.0, K nitrate 10.0, TNT 12.5, vaseline, or paraffin 0.5, chrome-alum 7.0%; b) Am nitrate 63.25, K nitrate 17.5, collodion cotton 9.25, vaseline or paraffin 0.5, chrome-alum 9.5%. [See Thorpe's Dictionary, v 4 (1940), p 554].

Chrome Plating of Gun Barrels. Experiments on the plating of tubes up to 88 mm caliber were conducted during WW II by the firm of Heinrich Reining GmbH, Enger (Westfalen). The thickness of plating ranged between 0.012 and 0.035 mm. No information is available as to outcome of the experiments CIOS 32-64).

Closed Cycle Diesel. See under U-Boat Walter.

Closed Vessel Testing. According to CIOS 31-68, pp 12-16, closed vessels were used for the following purposes:

a) The development of new propellants
b) Studies of particular properties of propellants
c) Obtaining data for ballistic calculations.

Tests designed for the first two purposes were carried out mainly at the Düneberg factory of Dynamit A.-G, while those for the 3rd purpose were made at the Essen factory of Krupp. A certain amount of closed vessel testing of small arms propellants was done in the DWM (Deutsche Waffen- und Munitionsfabriken) research laboratory at Lübeck.

Cold Extrusion Process (Kaltspritzen) (literally cold-squirting) as used during WW II by the Germans in the manufacture of ammunition and weapons is briefly described in the following PB Report prepared in the period 1945-1948 by the Heintz Manufacturing Co, Philadelphia Pennsylvania: Nos 39371, 96704 and 96704s (See also Cold Extrusion in the general section).

Colored Smoke (Buntrauch). The bulk of the work on the development of dyes suitable for use in colored smokes was done by the IG Farbenindustrie. The pamphlet "IG-187r" of the Office of Technical Services gives a list of these dyes.

The following references describe some German colored smokes and smoke signals:

1) W.T.Annasovich & E.C.Stawick, "German Smoke Signals", PB Rept 49467 (1944)
2) H.J.Eppig, "Chemical Composition of German Pyrotechnic Smoke Signals", PB Rept 16728 (1945)
3) J.Kanegis, "Colored Smokes", PB Rept 102,500 (1951) (Included are several tables of colored smoke compositions and some references)

(See also Colored Smokes in the general section).

Colored Smoke Ammunition. See under Signal Device and under Smoke Projectile.

Commercial (Industrial or Mining) Explosives (Gewerbliche-sprengstoffe oder Zivilsprengstoffe) Predating WW I.
The first application of explosives (black powder) in mining was made, according to Beyling and Drekopf, in 1627 when an Austrian, Casper Weindl blasted some ore at Ober-Biberstollen in Hungary. The next mine blasting was done in 1632 near Clausthal, and then in 1645 near Freiburg, Germany. The first blasting in England took place in 1670. From that time on the blasting of coal and ores, spread to other countries. Black powders of various compositions were used exclusively until about 1865 when A.Nobel introduced NG dynamites (See under Swedish Explosives).

Among the commercial explosives used in Germany prior to WW II, the following may be listed: Ammonal, Ammonchlorat, Ammongelatine, Ammonit, Bikarbit, Calcinit, Cheddit, Chloratit, Detonit, Donarit, Dynamit, Gelotit, Gestein-Albit, Gestein-Koronit, Gestein-Persalit, Guhrdynamit, Leonit, Miedziankit, Wetterdetonit, Wetterlignosit, Wetternobelit, Wettersalit, Wetterwasagit, Wetterwestfalit, Wetterzellit and others.

These explosives are described briefly in this (German) section of the book according to their alphabetical order. Some of the typical explosives used during WW II are given in Table 9 under Commercial Explosives of WW II.

It is interesting to note that some of the commercial explosives used before WW I were manufactured from surplus military explosives and propellants. Among these explosives were: Energit, Nitroglycerin Powders No 1 and No 2, Pikrit (or Silvit), Pyrolit No 1 and No 2 and Triwestfalit.

References:
1) P.Naoúm, Nitroglycerin and Nitroglycerin Explosives (translated from the German by F.M.Symmes), Williams & Wilkins, Baltimore (1928)
2) A.Stettbacher, Schiess- und Sprengstoffe, J.A.Barth, Leipzig (1933)
3) C.Beyling & K.Drekopf, Sprengstoffe und Zündmittel, J.Springer, Berlin (1936)
4) A.Stettbacher, Spreng- und Schiessstoffe, Rascher, Zürich (1948).

COMMERCIAL (INDUSTRIAL OR MINING) EXPLOSIVES (GEWERBLICHESPRENGSTOFFE) OF WW II. Among the German industrial (mining) explosives, the most important were dynamite-type explosives containing various amounts of a product obtained by nitrating a mixture of glycerin and glycol (usually 60/40). The nitration of glycerin and glycol is described briefly under Nitroglycerin.

There were generally two types of mining explosives: the gelatinized type (such as some donarites) and the powder type (such as calcinite and some donarites).

Following is a short description of their methods of manufacture:

A) Gelatin type explosives

Procedure

a) A weighed amount of collodion cotton (previously dried at 50-60° in a rack dryer to a moisture content of about 1% and then cooled) was introduced into a kneading pan which contained the required amount of liquid DNT, or other liquid nitrocompound, maintained at a temperature of 15-20°. The mass was stirred all the while with a long handled wooden spatula. The kneading pan was a flat vessel made of copper plate with an outer jacket of aluminum for warm water heating. This operation was followed by addition of a weighed amount of NG-nitroglycol mixture, while continuing the hand stirring. The resulting gelatin was allowed to stand for 1 hour.

Note: For Am nitrate-type explosives, the plasticity was sometimes controlled by adding a solution of "gelose".

b) The pan was removed to another building where it was placed under the outlet funnel of a sieve through which the usual solid components of dynamites (such as Am or Na nitrates, TNT, wood meal, dye, etc) were fed. These components were previously pulverized and dry blended in another building. While the addition of the solid ingredients took place, the mass in the pan was stirred by means of a planetary stirring mechanism, which could be lowered or raised as desired. Kneading time was usually about 20 minutes.

Note: Several types of mixers (blenders) were used, such as the Draiswercke, Wetzig, McRoberts and a modified Werner-Pfleiderer.

c) The thoroughly kneaded mass of gelatin and of solid components was removed by a wooden hand spatula into wooden transport boxes to be carried to the cartridging plant.

Note: German permissible explosives were usually white in color, while the non-permissible were colored red by the addition of caput mortum (Fe_2O_3) in the mixing stage.

d) Cartridging was done either by fully automatic machines (such as the system of Niepmann & Co, Gevelsberg) or by semi-automatic machines (such as the system of Brensing). The Brensing machine (made entirely of brass) consisted of a conical casing through which passed a horizontal feeding screw. The gelatinized mass was introduced into the machine by hand through the filling funnel. A paper cartridge was placed at the narrow end of the conical casing. After a cartridge was filled, it was removed by hand and the open end crimped. The diameter of a cartridge was 22, 25 or 30 mm. After packing these cartridges into a box (36, 25 and 20 cartridges per box, respectively), the box was wrapped in paper and dipped in paraffin. For shipping, 10 boxes were packed in a case.

e) Permissible explosives were mechanically sheathed with an "active sheath" consisting of NG 12, NaCl 33, and $NaHCO_3$ 55%. Originally, the composition of the sheath was NG 15, NaCl 35, $NaHCO_3$ 50%. The sheath weighed 55 g and the cartridge itself 70 g.

B) Powder type explosives: To this type belong explosives which contained small amounts of NG (such as 4%), no collodion cotton and were pulverulent. The mixing of the components was done in a tiltable type Werner-Pfleiderer blender which consisted of a brass trough provided with two horizontal brass stirring rollers running in opposite directions.

Procedure:

a) The weighed amounts of the solid components (such as Am, Ca or Na nitrates, TNT, wood meal, dye etc, were mixed in a Werner-Pfleiderer blender [illegible] then the liquid DNT, NG, NGc etc , were added [illegible] mass kneaded for 15 minutes

b) The kneader was then tilted and [illegible] discharged into wooden casks to be taken to the [illegible]idging plant.

Note; In the case of explosives such as Calcinit I , the mass could be immediately cartridged, but with Donarit I , the mass had to be left overnight in storage before cartridging.

c) Cartridging was usually done by fully automatic

machines of the Niepmann type. Diameter of cartridges for Calcinit 1 was 28 mm, while for Donarit 1 it was 30 mm. The finished cartridges of Donarit 1 were dipped in paraffin and packed in boxes (25 per box). The cartridges of Calcinit 1 were not paraffined but were packed directly in boxes (32 per box) and the boxes were dipped in paraffin.

Table 9 gives some typical German Commercial Explosives manufactured before and during WW I.

Table 9

Ingredients and some properties	Ammonit 1 (1932)	Donarit	Dynamit I	Gelatine-Donarit I (1936)	Wetter-Donarit A (1936)	Wetter-Nobelit A (1932)	Wetter-Nobelit B (1932)	Wetter-Wasagit A	Wetter-Wasagit B	Wetter-Westfalit A (Permissible)
NG(Nitroglycerin)	4.0	4.0	63.0	-	6.0	25.4	29.2	30.0	27.8	4.0
NGc (Nitroglycol)	-	-	-	22.0	-	-	-	-	-	-
NC(Nitrocellulose)	-	-	2.0	0.8	-	0.6	0.8	1.0	0.7	-
TNT(Trinitrotoluene)	6.0	12.0	-	5.0	2.0	-	-	-	-	0.5
DNT(Dinitrotoluene)(liquid)	6.0	2.0	-	6.0	-	2.0	-	-	-	0.5
Am nitrate	80.2	79.8	-	55.0	72.0	32.0	26.5	29.5	30.5	80.5
Na nitrate	-	-	26.7	10.0	-	-	-	-	-	-
Wood meal	3.5	2.0	8.0	1.0	2.0	1.0	0.5	-	0.3	1.5
Rock salt(NaCl)	-	-	-	-	18.0	36.5	40.0	39.0	39.5	13.0
Caput mortum (Fe_2O_3)	0.3	0.2	0.3	0.2	-	-	-	-	-	-
Gelose (Carragan moss)	-	-	-	-	-	-	-	0.5	0.7	-
Talc	-	-	-	-	-	-	-	-	0.5	-
50% Ca nitrate solution	-	-	-	-	-	2.5	3.0	-	-	-
Trauzl Test, cc	370.0	-	385.0	380.0	220.0	205.0	185.0	-	-	-
Lead Block Compression, mm	17.5	-	23.0	20.0	10.5	16.5	14.5	-	-	-
Veloc of Deton, m/sec	4800(at d=1.12)	-	6350	6150	3000(at d=1.10)	5750	5650	-	-	-
Cartridge Density, g/cc	1.07	-	1.53	1.53	1.06	1.66	1.69	-	-	-
Gap Test, cm	6.0	-	10.0	10.0	8.0	6.0	-	-	-	-
Charge Limit, g	-	-	-	-	600	700	700	-	-	-
Oxygen Balance,%	+0.06	-	+3.0	+3.68	+10.4	+4.08	+6.15	-	-	-
Heat of Explosion, kcal/kg	996.0	-	1291	1029	516	642.0	568.0	-	-	-
Gas Volume, l/kg	904.0	-	603.0	806.0	772.0	536.0	500.0	-	-	-

Note: The composition of sheaths used with some of these explosives are given under Active Sheath.

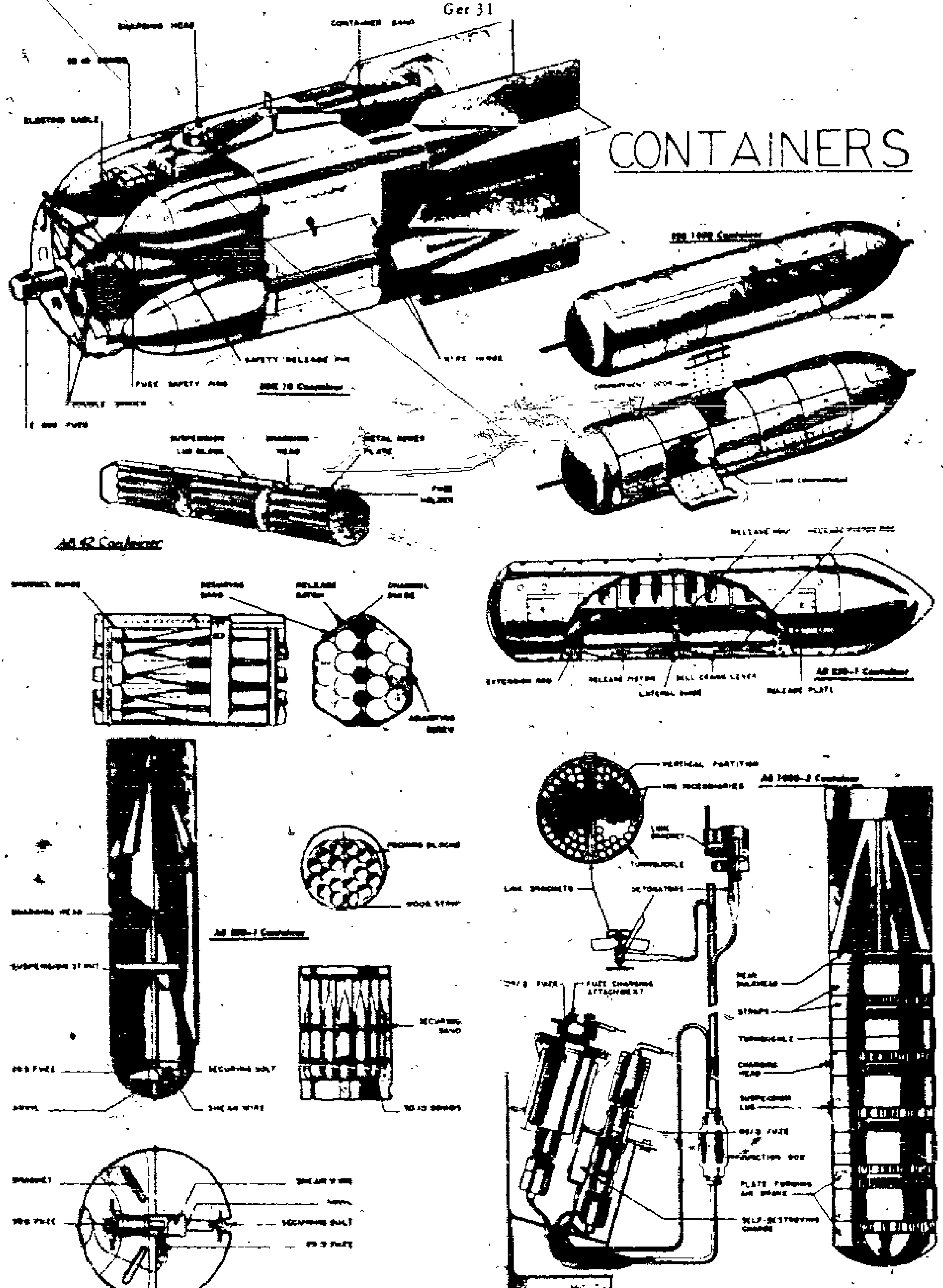
References:
1) O.W.Strickland, General Summary of Explosives Plants, PB Rept 925 (1945), p 69
2) R.Ashcroft, et al, Investigation of German Commercial Explosives, B I O S Final Rept 833, Item 2
3) R.Ashcroft, et al, Investigation of German Commercial Explosives, PB Rept 63,877 (1946), pp A 1/8 and A 1/11.

Complete Round of Artillery Ammunition. See under Granate

Composition A (Comp A) A mixture of RDX 90-97 and Montan wax 10-3%, similar in properties to Comp A used in the U S A during WW I and described in the general section. German uses of Comp A were in boosters, sub-boosters and as a filler in some grenades and shaped charges. (See also Filler No 86, No 91 and No 92).
Reference: Allied and Enemy Explosives, Aberdeen Proving Ground, Md, (1946), p 122.

Composition B (Comp B) (Cyclotol) A mixture of RDX and TNT in various proportions similar to Comp B described in the general section. Some of the compositions contained small amounts of wax. Comp B was used by Germans, during WW I for filling shaped charge shells, grenades, rockets, and some demolition charges. Pellets of Comp B embedded in TNT were used in 4000 kg bombs.
(See also Filler No 18 and Filler No 95).
Reference: Allied and Enemy Explosives (1946), p 124.

Composition C. A plastic explosive similar in properties



to Comp C described in the general section and the PHE used by the British during WW I. The German version is described here as "Plastit"
Reference: Allied and Enemy Explosives (1946), p 127.

Concrete Ball Mine. See p 276 of TM 9-1985-2 (1953) and also under Landminen.

Connecting (or Intermediate) Composition. See under Gasless Detonators (Electric).

Containers Carried by Planes. German containers may be subdivided into (1) those intended to carry their contents safely to earth and (2) those designed to scatter their contents before impact.

The first type served to deliver supplies to specific locations and generally consisted of a compartment to house the supplies and a parachute to bring the container safely to earth. No explosive opening devices were incorporated.

The second type could be subdivided into dropable and nondropable (retained in the aircraft) containers and also according to content into bomb container, flare container or combination bomb-flare container.

Dropable containers were fitted with fuzing and opening devices intended to release the missiles after a predetermined time of fall from the aircraft. Some of these were open devices which held a cluster of bombs or flares by means of securing bands, whereas others were closed containers in the shape of a bomb.

Nondropable containers were intended to be used repeatedly and they were constructed to carry and scatter a great number of small incendiary bombs. Their release mechanism permitted desired spacing of the bombs in flight These containers could be jettisoned if necessary.

The following bomb and flare containers are described in TM 9-1985-2 (1953), pp 93-120:

1) BDE 10 Cluster Container carried five SC 10 or SD 10A bombs (pp 93-5)
2) AB 23 SD 2 Container carried 23 SD 2 bombs (pp 95-7)
3) AB 24T SD2 Container carried 12 SD 2 bombs (pp 96-8)
4) AB 36 Container carried 36 1kg or 24 2kg bombs (p 98)
5) BSK 36 Three-Sided Container carried 36 1 kg or 16 2 kg bombs (p 98)
6) AB 42 Container carried 42 1 kg incendiaries (pp 99-100)
7) AB 70-1 or Mark 70S Container carried 3 Mark S flares (pp 100-1)
8) AB 70-3 Container carried 22 SD 2 bombs (pp 101-3)
9) AB 70D-1 Container carried 50 SD 1 bombs (p 104)
10) AB 250-1 Container carried 96 SD 2 bombs (pp 104-6)
11) AB 250-2 Container could carry 224 SD 1 bombs, or 144 SD 2 bombs, or 17 SD 10A bombs, (pp 106-7)
12) AB 250-3 Types I and II Containers carried 108 SD 2 bombs (p 107)
13) AB 250 KZ Boden-Container could carry 19 parachute flares and three SD 2 bombs (p 108)
14) Mk 250 LK Flare Container carried 41 single candle parachute flares (pp 108-9)
15) Mk 250 BK carried 25 modified red flares and three SD 2 bombs (pp 108-9)
16) BSB 360 Container carried 320 1 kg incendiary bombs (p 110)
17) BSB 700 carried 702 1 kg incendiary bombs (p 110)
18) BSB 1000 carried 570 1 kg incendiary bombs (p 110)
19) AB 500-1 Container could carry one of the following fillings: 37 SD 10A bombs, 392 SD1 bombs, 184 1 kg incendiary bombs, 28 SD 10FRZ bombs or 116 2 kg incendiary bombs (pp 111-13)
20) AB 500-3A Cluster Adapter could carry 4 SD 50 kg or SK 70 kg French bombs, as well as 50 or 100 kg French bombs (pp 113-15)
21) AB 500-1B Container carried 28 SD 10FRZ bombs (p 115)
22) ABB 500 Container carried 133 1 kg incendiary bombs (p 116)
23) "Streubrand C 500" Container (lit Scatter Incendiary Bomb) carried 1200 green celluloid incendiary boxes immersed in water (p 117)
24) Mk 500 "Boder" Container carried 9 or 15 single candle flares or 6 SD 2 bombs (p 117)
25) AB 1000-2 Container carried one of the following fillings: 620 1 kg bombs, 246 1 kg and 234 2 kg bombs, or 372 2 kg bombs (p 119) (See illustrations).

Continuous Methods of Manufacture of Explosives. See Kontinuierliche Verfahren.

Cordite Charge Casings. According to CIOS 31-68, p 8, propellent tubes in smaller guns (caliber below about 200 mm) ran the full length of the charge and there was only one section, while for larger guns the charge was in two sections, the **Hauptkartusche** (main charge) and the **Vorkartusche** (forward charge). Both these charges were in silk bags placed in the cartridge called **Kartusche** which was not rigidly attached to projectile. Any additional charges of propellant were called **Teilladungen** (increments).

For the largest of these guns the silk bag was found to be insufficient protection for the Vorkartusche and it was bound with a brass strip. Owing to a shortage of brass these strips were replaced in the later part of WW II, by a large cordite cylinder surrounding the charge. The casing was made by bending a sheet of cordite into a cylindrical shape and by joining the edges using a NC solvent. Each end of the cylinder was closed by a cap made of the same material.

Coronit (Coronite). An early blasting explosive used in stone quarries and ore mines: Na chlorate 72, NG 3, TNT with DNT 20, paraffin 4, vegetable meal 1%. Has been replaced by Percoronite (qv). [J.Bebie, Manual of Explosives etc, MacMillan N Y (1943), p 52].

"C" Process of Precision Casting of Metals. See Shell Mold Process.

Cracking of Sulfuric Acid. See Lurgi Spaltanlage.

Cresylit (Cresylite). Same as Trinitrocresol.

C-Stoff (C-Stuff) A liquid rocket fuel consisting of 50/50 mixture of hydrazine hydrate and methanol. The combination of this fuel with concentrated (80%) hydrogen peroxide (called T-Stoff) was used in the rocket fighter plane Heinkel 173 at the end of WW II
Reference: J.G.Tschinkel, Chem & Eng News **32**, 2586-7 (1954) (Propellants for Rockets and Space Ships).

Note: According to CIOS Rept 30-115 (1945), pp 8-10 & 13, the **C-Stoff** consisted of hydrazine hydrate 30, methanol 57 and total water 13%. Water was incorporated in order to reduce the combustion temperature in rocket chambers). To this mixture was added K cuprocyanide (0.6 g of Cu per liter of C-Stoff) serving as catalyst. The mixture had a specific gravity 0.915 at 20°C. On mixing C-Stoff with T-Stoff, the liquid ignited spontaneously and the gaseous products served for driving the aircraft rocket units, the guided missiles and the ATO units.

The following plastic materials were reported to withstand the action of C-Stoff very well: polyvinylchloride (without softener), polyamide and Buna S. Polyethylene was good, while polyvinylchloride with tricresylphosphate as softener was not suitable.
(See also B-Stoff, M-Stoff and T-Stoff).

CTR. See Chemisch-Technische Reichsanstalt.

Cyclonite See Hexogen.

Cyclotol. See Composition B.

Dahmen Explosives were invented by J. von Dahmen of Austria and used in Austria, Belgium, Germany and probably England. In Germany they were manufactured by Castroper Sicherheits-Sprengstoff A-G at Castrop (Westfalen):

a) Am nitrate 92.0, phenanthrene 5.5, K bichromate 2.5%
b) Am nitrate 30, sawdust 35, K bichromate 3, NG 30%.

Reference: J.Daniel, Dictionnaire, Dunod, Paris, (1902), pp 791-2.

Dahmenit A (Dahmenite A). One of the Favier type explosives: Am-nitrate 90.8, K bichromate 2.2, naphthalene 6.5, curcuma 0.5%; vel of deton 3680 m/sec at d 1.02 [Marshall, v 2 (1917), p 493].

Decomposition Number of Hydrogen Peroxide is the ratio of the concentration of peroxide after being heated at 96°C for 24 hours to the original concentration (CIOS 30-115, p 9).

Decoppering Agent (Entkupferungsmittel). According to Pic Arsn Tech Rept 1555 (1945), p 30 the following compositions were found in some German ammunition captured during WWII.

a) Tin 60, lead 38, bismuth 1.8 and antimony 0.2%; used in some 37 mm HE shells.
b) Tin 61 and lead 39%; used in some 40 mm HE shells.

Note: According to E. Englesburg, The Ordnance Sergeant, May 1944 the usual German decoppering agent consisted of a lead wire wrapped around the propellent bag or placed on top of it. Upon deflagration of the charge the wire formed a brittle alloy with the copper of the rotating band, and this alloy was rubbed off by the inner surface of the gun barrel. When the next charge containing no decoppering agent was fired, the shell shattered the brittle alloy, thus clearing the gun tube.

Deep Bonding Process. See Tiefbonder Verfahren.

Deflagration Temperature Test (Verpuffungs-Probe). See Ignition or Explosion Temperature Test.

Delay Compositions (Verzögerungsverbindungen). A brief description of such compositions is given in the general section.

Shortly before WWII, the Germans developed gasless delay compositions suitable for electric detonators. These mixtures consisted of powdered potassium permanganate ($KMnO_4$) and antimony (Sb). Following is a brief description of the method of preparation as conducted at the Troisdorf plant:

Procedure:

The dry crystalline K permanganate was ground in a special mill (called Kolloplex) to a particle size of about 0.006 mm. The antimony, received at the plant in a fairly finely devided state, was ground, without previous drying or other treatment, in a special mill (called Schwingmühle). The resulting powder was separated in an air elutriator into fine (grist size under 40 microns) and coarser fractions. The coarser fraction was placed on a vibrating sieve containing 16,900 meshes per cm^2 and the fraction retained on the sieve was used as coarse Sb. For the preparation of quick burning mixtures the fine Sb was used, while for slow mixtures the coarse material was more suitable. For instance a mixture of 36% fine Sb with 64% $KMnO_4$ loaded into No 10 delay element (q v) burned in 3.5 to 4.5 seconds, while the mixture of 36% coarse Sb and 64% $KMnO_4$ burned in 6.5 to 7.5 seconds. With a lower content of Sb and a higher content of $KMnO_4$ the burning time was longer. In order to obtain a composition with a desired delay, the coarse Sb was blended with the fine material.

Following is an example of the calculation for preparing a delay composition with a desired delay:

Suppose that it is necessary to prepare 80 kg of delay composition consisting of 36% Sb and 64% $KMnO_4$ which would burn for 4.85 sec in a No. 10 delay element. The time of burning of coarse material is 7.50 sec and of the fine 3.50 sec.

If the "rectangle method" is used for computation (as is customary in Germany and some other countries of Europe) the calculation will be made by setting up the data shown below:

$$\begin{array}{ccccc} 7.50 & \text{———} & 1.35 & \text{———} & X\,\text{kg (coarse Sb)} \\ & 4.85 & & & \\ 3.50 & \text{———} & 2.65 & \text{———} & (80\text{-}X)\,\text{kg (fine Sb)} \end{array}$$

In this configuration 1.35 is the difference between 4.85 and 3.50 and 2.65 is the difference between 7.50 and 4.85 seconds.

From the above, X may be calculated as follows:

$$X = \frac{1.35 \times (80\text{-}X)}{2.65} = \frac{1.35 \times 80}{2.65} - \frac{1.35X}{2.65} = \frac{108}{2.65} - \frac{1.35X}{2.65}$$

$$2.65X = 108 - 1.35X \text{ or } X = \frac{108}{4} = 27 \text{ kg (coarse).}$$

The amount of fine material is then (80-X), or (80-27)= 53 kg.

After thoroughly mixing 27 kg of coarse Sb with 53 kg of fine Sb, a small sample consisting of 36 parts of mixed Sb and 64 pts of $KMnO_4$ was prepd and tested in a No 10 delay element. If instead of the desired time of 4.85, 5.15 sec was actually obtained, then this Sb mixture would need to be corrected by adding some fine Sb (3.50 sec). The amount of fine Sb to be added was calculated using the "rectangle" method as described above and a small sample of new, corrected, mixture was prepared. If the burning time in a No 10 delay element was exactly the desired 4.85 sec, the total batch consisting of 36% of "corrected" Sb and 64% of $KMnO_4$ was blended and pelleted. The pellets were ground and screened using sieves of 225 and 961 meshes per cm^2. The material which passed the 225 mesh sieve and was retained on the 961 mesh sieve was removed to storage while the material which was retained on the coarser sieve was reground and rescreened as above. The fine material (dust) which passed through the 961 mesh sieve was saved for adding to compositions considered to be too slow burning.

Before commencing to load a delay element (qv) with the above prepd mixture, it was tested as follows:

a) Moisture content. A weighed sample of a delay mixture (5-10g) was heated for 2 hours at 110°. If the loss of weight exceeded 0.2% the entire batch of delay composition was dried for several hours at 50° in a steam heated oven before it was loaded into delay elements.
b) Particle size of Sb. A weighed sample of a delay mixture was leached in a Gooch-type crucible with hot water to remove the $KMnO_4$ and the particle size of the dried weighed Sb powder was determined (Refs 2 and 3).

Note: The method for determination of particle size is not describedin the references given below.

A different type of delay composition consisting of NC, red lead (Pb_3O_4) and silicon was used for the 200 mm HE mortar bomb. The composition in the sleeve was: NC 3.9, red lead 75.5 and silicon 20.6%, while in the pellet it was: NC 2.7, red lead 72.0 and silicon 25.3% (Ref 1)

References:

1) W.R.Tomlinson Jr, Pic Arsn Tech Rept 1555 (1945), p 30
2) R.Ashcroft, B I O S Final Rept 833, H M Stationery Office, London (1946), Item 2, pp A3/7 to A3/12
3) Anon, PB Rept 95,613 (1947) (Manufacture of German Detonators and Detonating Compositions).

Delay Elements (Verzögerungskörper). The elements used

during WWII consisted of metallic sleeves (of Al, Cu, brass, or coppered Fe) loaded with "gasless delay composition" (q v) consisting of powdered $KMnO_4$ 64 and Sb 36%. The sleeves had an inside diameter 3.30 to 3.45 mm and an outside diameter of 6.45 ± 0.02 mm. The length (L) of the sleeves when using brass was as follows:

Delay in sec	1	2	3	4	5	6
L in mm	3	5.5	8	10.5	13	15.5
Delay in sec	7	8	9	10	11	12
L in mm	18.5	21.2	24.2	27	29.5	32

Loading of the sleeves was done by means of a 70 ton hydraulic press at pressures of 950 kg/cm^2. Details of the method are given in Ref 2, section F.

The above delay elements were used in electric detonators, described briefly under Detonators (Electric).

References:

1) R.Ashcroft, B I O S Final Rep No 833, H M S O, London (1946)
2) Anon, PB Rept No 95 613 (1947), Sections F & G.

Demolition Charge (Sprengladung oder Sprengkörper) The following charges were examined during WWII by U S Ordnance Dept establishments:

a) Bohrpatrone 28 (Blasting cartridge pattern 1928). A cartridge 3.9" long and 1.2" diameter, consisting of 3½ oz of TNT or P A wrapped in waxed paper
b) Sprengpatrone 28. A cartridge 4.1" long and 1.4" diam., consisting of P A wrapped in varnished paper
c) Sprengkörper 28 (Demolition block pattern 1928). A block 2¾ x 2 x 1½" consisting of 7 oz of TNT or P A wrapped in waxed paper
d) Sprengkörper 28 consisting of two blocks of TNT, total wt 7 oz placed in a bakelite container 3 x 1.8 x 2.2"
e) Sprengbüchse 24 (Demolition block in container, pattern 1924). A block of TNT or P A weighing 2 lb 3 oz placed in a zinc container 7.9 x 2.9 x 2.2"
f) Sprengbüchse 24. A block of 90/10 - PETN/Wax weighing 2 lb 3 oz
g) Geballteladung 3 kg (Concentrated charge 3 kg). The demolition charge consisted of several blocks of TNT or P A with a total weight of 6.5 lb, placed in a zinc container (7.7 x 6.5 x 3") provided with carrying handle
h) Geballteladung 10 kg. Same as above except that it contained 22 lb TNT. The size of zinc container was 10⅜ x 7⅝ x 5¾"
i) 12.3 kg Demolition Charge. A triangular block of 27 lb RDX/TNT in a seamless steel container.
j) Plastit. A block of plastic explosive RDX/Oil weighing 1 lb 1½ oz
k) 300 g Hohlladung (Hollow charge). A shaped charge of a HE; size 3½" high and 2.8" diameter
l) 400 g Hohlladung. A shaped charge consisting of 12 oz of PETN/Wax in an aluminum case 3.1" high and 2.8" in diam
m) 12.5 kg Hohlladung. A shaped charge consisting of 28 lbs (with a container) of TNT in a sheet iron case 8.1" high and 11" diameter
n) 13.5 kg Hohlladung. A shaped charge consisting of 21 lb 3 oz (without a container) of 50/50 - RDX/TNT in a mild steel container 9" high and 13½" diameter
o) 50 kg Hohlladung. A shaped charge consisting of 110 lb (with a container) of TNT in a sheet iron case 10.2" high and 20" diameter, provided with a carrying handle
p) 500 g Hafthohlladung (Magnetic antitank hollow charge). A shaped charge of a HE weighing 1 lb 1¼ oz
r) 3 kg Hafthohlladung. A shaped charge consisting of 1 lb 50/50 - RDX/TNT mixture in a metal container 7.7" high and 6.2" diameter
s) 3.6 kg Hafthohlladung. A shaped charge consisting of 2¼ lb TNT in an aluminum container.

References.

1) Picatinny Arsenal Technical Rept No 1555 (1945), p 31
2) U S War Dept Technical Manual FM 5-25 (1945), pp 129-132
3) Dept of the Army Field Manual FM 5-25 (1954), pp 196-7.

Density of Fragments Test. See Fragments Density Test.

Derne Mining Association Testing Station. See under Galleries, Testing, in the general section.

Detonationsdruck (Blast Pressure). See general section.

Detonationsfähigkeit (Ability to Detonate or Sensitivity to Initiation). The value is usually expressed by the smallest numbered standard cap required to initiate the explosive under test. For instance, in Naoúm's book Schiess- und Sprengstoffe, 1927 p 121, it is said that in order to initiate Ammonit 2 a No 3 cap is required, while for Ammonit 1 and 5, a No 1 cap suffices. This means that Ammonit 2 is less sensitive to initiation than are ammonites 1 and 5. The same test is used in Italy.

Detonationsgeschwindigkeit (Velocity of Detonation). See general section.

Detonationsübertragung; Schlagweite (Transmission of Detonation, Striking distance). Also called "Sympathetic Detonation". The test is similar to the Gap Test described in the general section. (See also Four Cartridge Test).

DETONATORS (Detonatoren); **BLASTING CAPS** (Sprengkapseln); **Igniters** (Zündern). A short description is given in the general section. A.Stettbacher, (Ref 1) defines detonators (Detonatoren) as reinforced blasting caps which are designed to initiate explosives which are difficult to detonate by means of ordinary blasting caps.

The following military detonators were examined at Picatinny Arsenal during WWII and described in Ref 4, p 30:

Detonator R contained 4 grains of 75/25-L A /L St mixture over 6.9 grains PETN.
Detonator T contained 3.9 grains of 42/58-L A /L St mixture over 10.8 grains of tetryl in an Al cap. Both detonators were used in HE hand grenades.
Some of the captured German detonators in fuzes (sometimes called gaines) examined at Picatinny Arsenal during WWII are listed in Table 11.

Following are the principal current commercial detonators and blasting caps:

Sprengkapsel A consists of an Al shell, 11 mm long, 4.36 mm in diam, filled with a 6 mm layer of PETN weighing 0.11 g (base charge) and a 3 mm layer, weighing 0.16 g of 80/20-L A /L St mixture, called in Germany the "Mischsatz" (primer mixture). Both the primary and secondary charges were press-loaded at 860 kg/cm^2 (Ref 6)

Table 11
Detonators

Designation	Composition (%) Upper charge	Intermediate charge	Lower charge	Uses
Gaine A	L A 59, L St 41%	RDX	RDX 92, wax 8%	Not indicated
Gaine B	L A 69, L St 31%	RDX	RDX 92, wax 8%	" " "
Gaine Model 40	L A /L St	-	PETN 87, wax 13%	" " "
Detonator	M F	-	Tetryl 49, TNT 51%	Land Mine
Gaine	L A 82, Sb_2S_3 7 and abrasive 11%	-	PETN	37 mm HE and 50 mm HE shells
"	L A with cover charge of black powder	-	PETN/TNT	47 mm APRN shell
"	L A 14.4 and L St 85.6%	-	PETN	47 mm AP shell
"	L A 55, L St 45%	-	PETN	Some 50 mm, 75 mm, 80 mm, 88 mm and 105 mm shells

Sprengkapsel B consists of an Al shell, 17 mm long, 7.5 mm in diam, filled with a 6 mm layer of PETN weighing 0.40 g (base charge) and a 4 mm layer, weighing 0.40 g of "Mischsatz" (primary charge) (Ref 6).

Note: In both above caps the L A was of technical grade, containing 92-94% of PbN_6 and not more than 0.35% moisture.

Some of the current commercial caps are described in Ref 7. The so-called "Normal copper cap No 8" (Kupfer-Normalsprengkapsel No 8) consists of a Cu shell, 6.8 to 6.9 mm in diam, press-loaded at 480 kg/cm² with 0.7 g TNT (base charge), placed in two layers each weighing 0.35 g and with 0.55 g of M F as the primary charge. The same Ref 7 compares the properties of flat-bottomed caps with those of shaped charges. While the Trauzl test value and Kast crusher test values are practically unaffected by a change in the shape of the bottom, the lead plate test value is much higher for the shaped charge.

A. Izzo, (Ref 8) describes the following German detonators: Detonator Brisko No 8 consists of a shell 40 mm long, 6.85 mm in diam, filled with 0.8g Tetryl compressed at 2000 kg/cm² (base charge) and 0.3g of L A /L St mixture (primary charge).
Detonator No 10 of D A -G, Troisdorf contained 1.25g of Tetryl and 0.3g of L A /L St mixture.

Abbreviations: L A Lead azide; L St Lead styphnate; M F Mercury fulminate; AP Armor-piercing; RN Round nose; HE High-explosive; PETN Pentaerythritol tetranitrate; RDX Cyclonite, or Hexogen; TNT Trinitrotoluene.

References:

1) A. Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), pp 348-352
2) C. Beyling & K. Drekopf, Sprengstoffe und Zündmittel, Springer, Berlin (1936), p 151
3) PB Rept 11,544 (1945), part III, p 10
4) Picatinny Arsenal Tech Rept 1555 (1945), pp 30-31
5) A. Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 105
6) W. Schneider, Sprengtechnik, No 10/11, p 186 (1952)
7) J. Kirsche, Sprengtechnik, No 12, pp 229-32 (1952)
8) Technical Report TM 9-1985-3 (1953), pp 547, 565, 566, 568, 569
9) A. Izzo, Manuale del Minatore Esplosivista, Hoepli, Milano (1953), p 77.
(See also BIOS Final Rept 644 and CIOS Rept 24-3).

Detonit (Detonite). A type of permissible explosive used before WW I. Some compositions are given in Table 12

Table 12

Composition and some properties	Detonit 3 (powdered)	Detonit 5	Detonit 6 (or 14A)	Detonit 14
Am nitrate	82.7	68.0	82.0	82.0
K nitrate	-	-	-	10.0
NG(mixed with NC)	4.0	4.0	-	-
NG(straight)	-	-	4.0	4.0
Aromatic nitro-compound	1.0	-	-	-
Vegetable meal	4.3	2.0	-	1.5
Wood meal	-	-	2.0	-
Coal (powdered)	-	4.0	0.5	-
MNN	-	-	1.0	2.5
Alkali chloride	-	22.0	-	-
Na chloride	8.0	-	10.5	-
Oxygen Balance	+10.3%	-4.8%	+10.9%	+13.6%
Trauzl Test	225cc	220cc	230cc	235cc

Abbreviations: MNN Mononitronaphthalene; NC Nitrocellulose; NG Nitroglycerin.

References:

1) Naoúm, Schiess- und Sprengstoffe (1927), p 146
2) Naoúm, Nitroglycerin (1928), pp 434-5
3) Beyling und Drekopf, Sprengstoffe und Zündmittel (1936), p 141.

Diäthylenglykoldinitrat (Diethyleneglycol Dinitrate). See Diglykolnitrat.

Diamin oder EDD (Ethylenediamine Dinitrate). See general section. EDD was used by the Germans in Fillers No 20, No 83, No 84 and No 86 as well as in the following mixtures of unknown names:

a) EDD 45 and Am nitrate 55%
b) EDD 45, Am nitrate 53.5 and Al 1.5%.

Note: Mixture of EDD and Am nitrate forms a eutectic which permits cast loading.
Reference: Allied and Enemy Explosives, Aberdeen Proving Ground, Md (1946), p 145.

Diazobenzolperchlorat (Diazobenzeneperchlorate). See general section.

Diazonitrobenzolperchlorat oder Nitrodiazobenzolperchlorat, known also as **Blitzpulver** is described in the general section under Diazobenzeneperchlorate.

Dichte (Density). See general section.

Dicyandiamid (Dicyandiamide). Its manufacture in Germany is described in BIOS Final Report 1720 (1947). (See also in the general section).

Didi-Pulver. An abbreviation for Diglykoldinitratpulver (Diethyleneglycoldinitrate Propellant) [Stettbacher, Spreng- und Schiesstoffe (1948), p 44].

Diesel Igniters. See Fuel Oil Igniters.

Diethylenglycoldinitrate. See Diglykoldinitrat.

Diethylnitramine, Hexanitro. See general section.

Diglykoldinitrat, Diglykolnitrat oder Didi (Diethyleneglycol Dinitrate) (DEGDN or DEGN). Preparation and properties are given in the general section.

Following is a brief description of the German method of prepn as practiced at the Krümmel Fabrik of D A -G:

a) 420 kg of technical "Diglykol" (DEG), contg about 1% of ethyleneglycol and about 0.1% of water, was run slowly with stirring into 1218 kg of mixed acid consisting of 65% nitric acid and 35% sulfuric acid. The acid was cooled to below 25° by brine circulated in cooling coils. Total time of nitration was 22 minutes.

Note: A great excess of nitric acid was used in order to retard the decomposition of the otherwise extremely unstable spent acid. While the NG spent acid remained fairly stable for days, the DEGDN acid had to be worked up at once since it decomposed rapidly on standing.

b) After the reaction was complete, the mixture was cooled to 15° and transferred to a separator where it was allowed to stand for 7 minutes. The spent acid (nitric acid 8-9, sulfuric acid 64-66 and nitrated products 4-5%) separated at the bottom, while the oil collected as the upper layer

c) The spent acid was then transferred to a "denitrator", while the oil, was run into the "primary washer" contg 300 liters of water stirred by air. The resulting acidic wash water contained an appreciable amount of nitric acid and was later denitrated

d) The oil was run into the "main washer" to be treated (with vigorous air-stirring) first with 500 l of cold water, then with 150 l of 5% soda ash soln, preheated to 60° and finally with 500 l of cold water

e) A sample of the oil thus purified was sent to the laboratory and if the KI test at 82° was not less than 20 min the material was considered to be satisfactory for use in the prepn of the so-called Rohpulvermasse (q v).

The yield of DEGDN was 710-715 kg or 170% of the DEG used; theoretically it should be 777 kg.

The purified DEGDN had the following properties: light yellowish oil, d 1.38 to 1.39, N content 14.1 to 14.2%, fr p below - 10°, b p (decomp ca 162° and puffs off ca 200°), calorific value 1070 kcal/kg (vs 1715 for NG), water calculated as liquid, impact sensitivity with 2 kg weight 160 cm (vs 4 cm for NG), solubility in water ca 0.4% at room temperature, and volatility ca 4-5 times more volatile than NG.

DEGDN was used in the so-called "cool" propellants, such as "G" Pulver and "Gudol" Pulver.

References:

1) O.W. Stickland, PB Rept No 925 (1945), p 57
2) A. Stettbacher, Spreng- und Schiesstoffe (1948), pp 61-2
(See also CIOS Report, 28-61).

Dimethylammonium Nitrate. See Di-Salz.

Dimethylethylenedinitramine (DMEDNA). Described in the general section. It was investigated by G. Römer, PBL Rept 85,160, p 14 as a component of some explosive compositions, such as:

1) DMEDNA 12, RDX 50, R-Salz 36, DPhA 1 and unaccounted 1%
2) DMEDNA 2.5, RDX 96.5 and DPhA 1.0%.

Dimethylnitramine (DMNA). Described in the general section. It was investigated by G. Römer, PBL Rept 85,160, p 13 as a possible addition to R-Salz in order to render it castable at temps of 100°, or lower. It was decided that incorporation of about 10% of DMNA was sufficient to give satisfactory results.

Dina. German abbreviation for Dinitronaphthalene.

Dinitroanilin (Dinitroaniline) (DNA). Described in the general section under Aniline. The Germans used DNA during WW II as an addition to TNT. The resulting explosive was yellow in color, less powerful than TNT and much less sensitive to impact or friction. It produced larger projectile fragments than did TNT [Allied and Enemy Explosives, Aberdeen Proving Ground (1946), p 90].

Dinitroanisol oder Disol (Dinitroanisole) (DNAns) See general section under Anisole; was used by the Germans in some explosive compositions, such as "Amatol No 40" (q v).

Dinitrobenzol (Dinitrobenzene) (DNB). See general section under Benzene. It was used by the Germans as an extender for TNT and as a desensitizer for some explosives, such as RDX. The addition of it to some high-melting explosives rendered them suitable for cast loading [Allied & Enemy Explosives, Aberdeen Proving Ground (1946), p 111].

Dinitrodiglykol. See Diglykoldinitrat.

Dinitrochlorhydrin (Dinitrochlorohydrin) (DNCH or DNClH) is described in the general section under Chlorohydrin.

Dinitroglykol (Dinitroglycol). See general section, under Glycol.

Dinitronaphthalin, Dina, (Dinitronaphthalene)(DNN). See

general section under Naphthalene. It was manufactured during WW I, together with trinitronaphthalene, at Semtin Fabrik at Pardubice, Czecho-Slovakia, and used in some composite explosives.
References:
1) PB Rept No 1820 (1945)
2) Allied and Enemy Explosives, Aberdeen Proving Ground (1946), p 117.
(See also in the general section under Naphthalene).

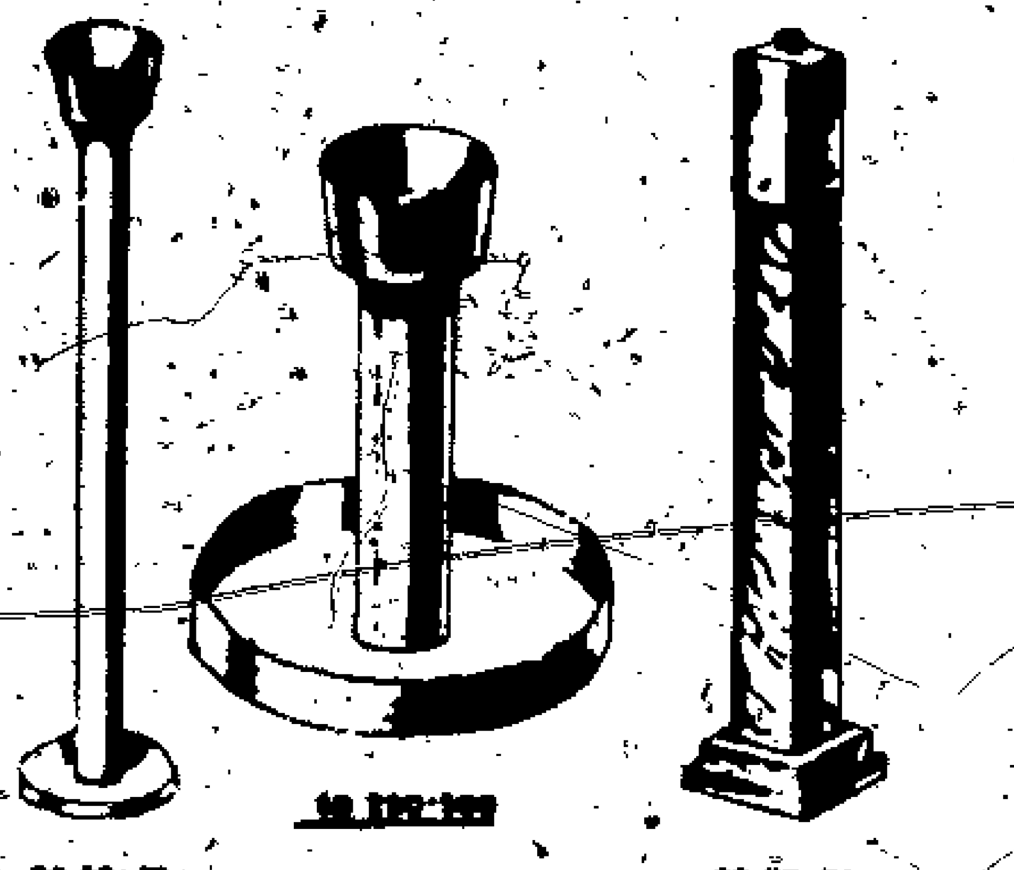
Dinitrophenol. See general section under Phenol.

Diglycerolnitrat (Liquid) (Known in the U S A as Drip oil). Was used by the Germans in some commercial explosives, such as Donarit.

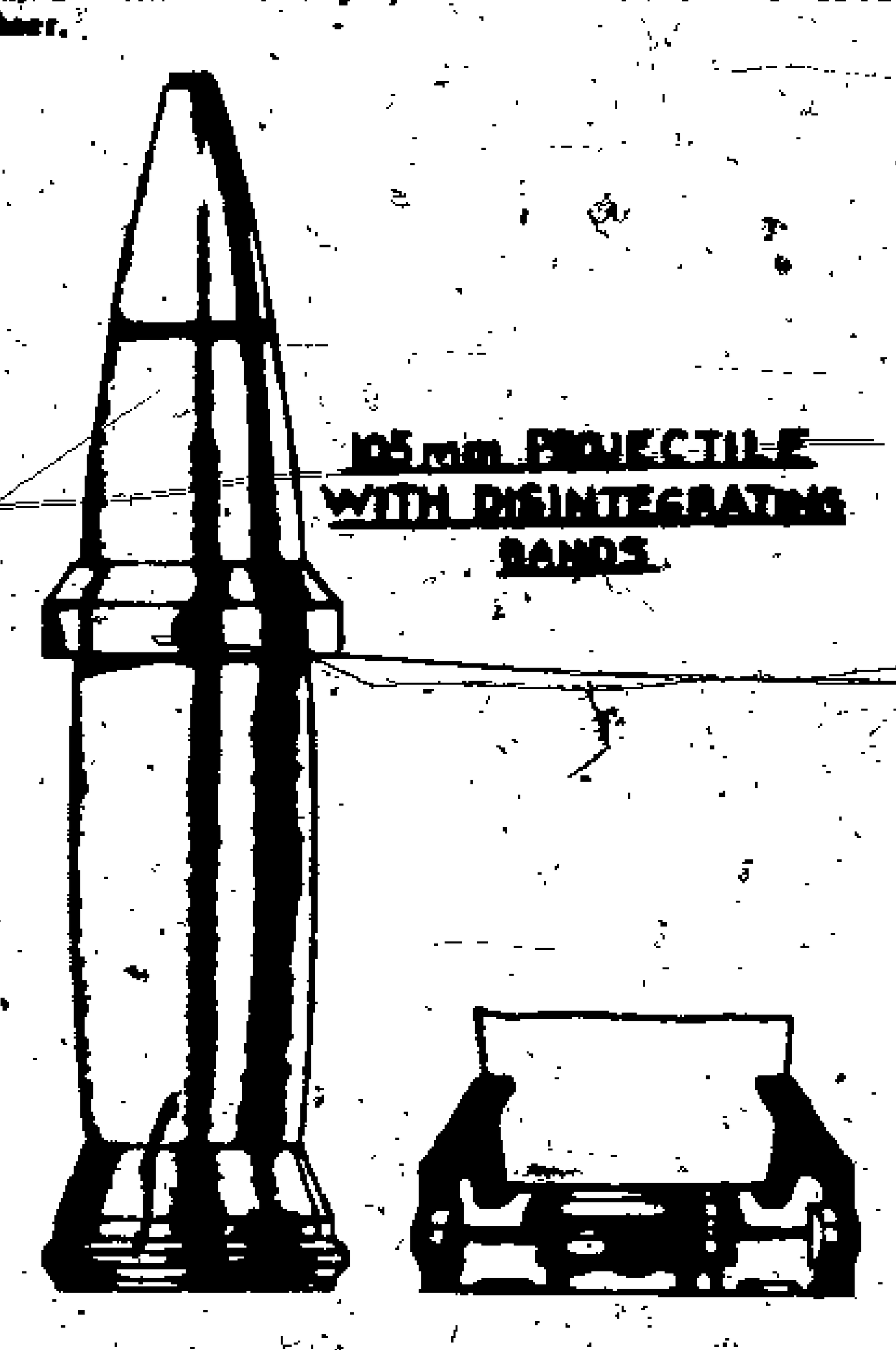
"Dinort" Rods were devices secured to the nose of A/P (antipersonnel) bombs to produce a burst above the ground. This assured a greater number of effective fragments close to the surface of the ground. Fragments would be ineffective if the bomb had penetrated the soil prior to bursting.
In the case of "shaped charge bombs" the Dinort rod acted as a stand-off device to improve the effectiveness of the charge (Ref 2)
There were two types of Dinort rods: a) drawn steel tubes (1.75" dia x 23.6" long or 2.75" dia x 14.8" long) and b) square wooden sticks (2.25 by 2.25" and 22.6" long) (Ref 1).
References:
1) Department of the Army Technical Manual TM 9-1985-2 (1953), p 4
2) J.H.Robinson, J.E.Capell and A.B.Schilling of Picatinny Arsenal; private communication (1955)

DI-SALZ. German abbreviation for Dimethylammonium Nitrate, one of the Ersatzsprengstoffe (substitute explosives) prepared in Germany during WW II, in order to combat the shortage of TNT and other high explosives. Di-Salt was prepd by the reaction of aqueous Dimethylamine with nitric acid (d 1.42). After vacuum distillation, a crystalline substance was obtained which decomposed explosively above 120°. The salt was found to be very unstable at temperatures above 100°. In the decomposition of Di-Salz, it was observed that free dimethylamine and nitric acid were produced first. This was followed by oxidation of the dimethylamine (by the nitric acid), which resulted in the progressive formation of nitrogen oxides as well as carbon oxides. The reaction accelerated autocatalytically into an explosion. When the salt was dissolved in water and then heated, strong hydrolysis took place.
No military application of this salt was reported.
References:
1) H.Walter et al, German Developments in High Explosives, PB Rept No 78,271 (1947)
2) F I A T Final Rept 1035 (1947), p 7.

Disintegrating Rotating Band Projectiles, such as 105 mm and 150 mm, were modifications of "sabot" projectiles. They contained at the shoulder a detachable guide band, which was almost completely trisected by cuts, spaced 120° apart. The band served as the bourrelet. The rotating band and its holder were located at the base of the shell, which was keyed to receive them. The holder itself was in three detachable segments held in position by the soft iron rotating band.
It is believed that after leaving the gun, the bourrelet and the driving band holder each split into three separate segments which were thrown off together with the pieces of metal which initially held them on the shell. The projectile which remained not only had a better aerodynamic shape than conventional projectiles but also was about 30% lighter.



Dinort-Rods



105 mm PROJECTILE WITH DISINTEGRATING BANDS

Dipentaerythritolhexanitrat. (Dipentaerythritolhexanitrate). See general section, and also V.Brün, SS 27, 73-76, 125-27, and 156-58 (1932).

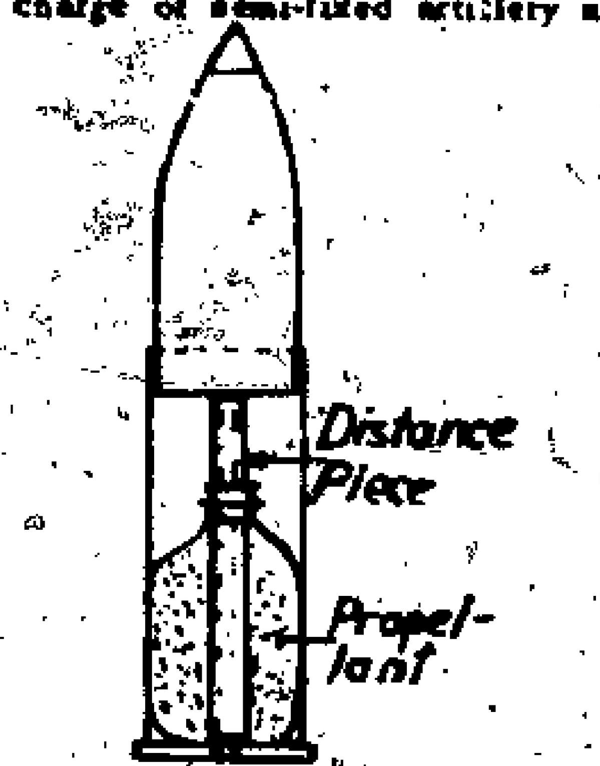
Diphenylamin (Diphenylamine) (DPhA). See general section.

Diphenylurethan (Diphenylurethane). See general section; was used by the Germans during WW I as a stabilizer in some of their smokeless propellants [PB Rept 11,544 (1944)].

Directed Missiles. See Guided Missiles.

References:
1) E.Englesburg, Ordnance Sergeant, May 1944, p 308
2) TM 9-1985-3 (1953), pp 369-71
(See Sabot Projectile).

Distance Piece (Kreuzrohr) (Cross Tube). When a propellent charge of semi-fixed artillery ammunition was smaller than a cartridge case, one or several tubular sticks of a double-base propellant were inserted into the propellent bag and tied tightly at its neck. The upper end of the sticks extended as far as the bottom surface of a closing cup (or the base of the projectile), while the lower ends held the bag against the primer. With this arrangement the propellent charge was not loose and, being held close to the primer flash hole, the propellant was readily ignited.



References:
1) E.Englesburg, The Ordnance Sergeant, May 1944, p 321
2) A.B.Schilling, Picatinny Arsenal; private communication (1955).

DMW-Pulver. Fast-burning NC propellant used in 7.65 mm standard cartridges for pistols and revolvers. It was in the form of small greenish cylinders 0.4 mm diam and 0.4 mm high, which were not graphited. [A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 45].

"Dobgerät". A device used for launching the "Taifun" rocket [TM 9-1985-2 (1953), p 223].

Donarit (Donarite). A type of mining explosive manufd in Germany for many years. It is known that at least one of donarites was used during WW II (under the name of Filler No 56) for military purposes.
Table 13 gives the composition of some mining donarites

Table 13

Composition (%)	Donarit 1 (Gelatin type)	Donarit 1 (Powdery type)	Donarit 2 (Powdery type)
Nitroglycerin	-	-	4.0
Nitroglycol	22.0		
Collod cotton	1.0	-	-
Am nitrate	55.0	81.5	84.0
Na nitrate	10.0	-	-
Aromatic nitrocompounds	-	-	3.0
Trinitrotoluene	5.0	14.0	-
Dinitrotoluene (liquid)	6.0	2.0	-
Wood meal	0.8	2.0	9.0
Dye(Caput mortum)	0.2	0.5	-

Note: The first two compositions were manufactured during WW II at the Krümmel Fabrik, of D A -G (Ref 2). The composition of Donarit 2 is given in Ref 1. According to Weichelt (Ref 3) there are three current donarites in Germany having the approximate composition: Am nitrate 86, Sprengöl (nitroglycerin with nitroglycol) 4-6 and TNT with Al powder 8-10%.
The properties of these donarites are as follows:

Temperature of explosion, °C	2580 to 3345°C
Volume of gases of explosion at NTP in l/kg	837 to 924
Cartridge density (including the paper)	0.87 to 0.98
Specific pressure, kg/cm^2	9900 to 10270
Velocity of detonation, m/sec	3800 to 4850
Trauzl test value, cc	435 to 480
Impact sensitivity with 2kg weight, in cm	60 to 70

(See also under Commercial Explosives).
References:
1) C.Beyling K.Drekopf, Sprengstoffe und Zündmittel, Springer, Berlin (1936), p 94
2) O.W.Stickland, General Summary of Explosive Plants, PB Rept No 925 (1945), p 69
3) F.Weichelt, Handbuch der gewerblichen Sprengtechnik, C.Marhold, Halle/Saale (1953), pp 37-8 & 375.

Doppelzünder (Double Igniter) for acoustic mines, developed during WW II at Troisdorf Fabrik D A -G. These mines consisted of two delay detonators (crimped into a sleeve) and mounted co-axially with their bases pointing away from each other, and with their fuseheads connected in series for simultaneous firing. The fuseheads had one direct connecting wire between them, while the other connecting wire from each of them made contact with a metal ring on the outside of the assembly. This arrangement permitted the fuseheads to be fired by applying an appropriate voltage to these two rings.
Reference: W.Taylor et al, BIOS Final Rept 644 (1945), p 17.

"Dora". Same as Sevastopol Gun, called also Gustav Geschütz.

Dortmund Gallery. See under Versuchsstrecke.

Drehspiegelkamera (Rotating mirror camera). See general section.

Drillingspulver. Short tubular powder for howitzers (Haubitze) such as the 10 cm Haubitze [Brunswig, Das rauchlose, Pulver (1926), p 131].

Duelin (Dualine). Under this name, Schultze, in 1868, patented a mixture of wood nitrocellulose and NG. Under the same name, Dittmar later patented a mixture of 50 NG, 30 nitrated sawdust and 20% saltpeter [Naoúm, Nitroglycerin (1928), p 282].

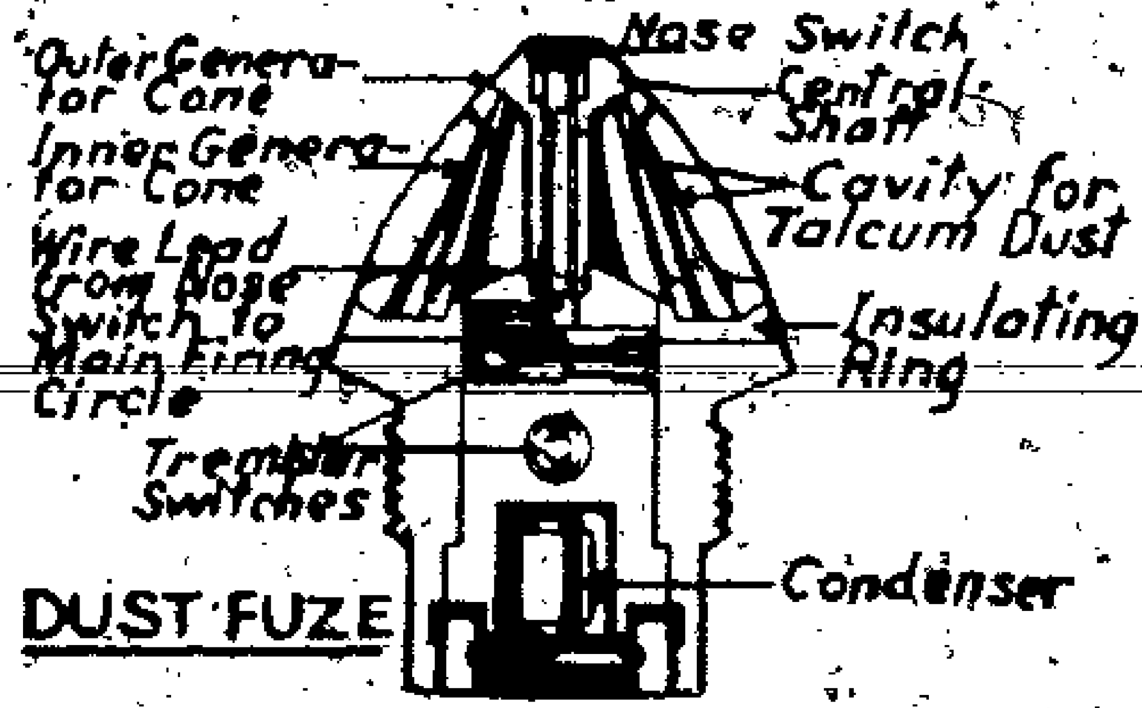
Durchschlags- und Strahlungsproben (Penetration and Radiation Tests). These tests are similar to those described in the general section under Lead Plate Test and Steel Plate Test. The German test is also called Brisanzplattenbeschuss, which means Brisance Plate Shooting.
References:
1) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), p 361
2) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), p 110.

Dust Fuze, developed during WW II at the Rheinmetall-Borsig, laboratory, was based on the principle of charging a condenser electrostatically by means of a dust field. The fuze was located in the nose of a bomb or a shell. Prior to dropping the bomb, the plastic cap covering the slits on the head of the fuze were removed. As the bomb fell, the air stream entered the fuze via the slits in the outer generator cone. This action disturbed the talcum powder and created a dust cloud in and around the forward part of the fuze. When the dust particles came into violent

contact with each other and also with the outer and inner generator cones, an electrostatic charge was developed. The condenser, which was connected to both generating cones, drew off the electric charge and built it up sufficiently to ignite the detonator on impact. (The size of the electric charge was controlled by the quantity of dust within the fuze).

The electric circuit could be closed for firing by any of three switches: a nose contact switch or two trembler switches set at right angles to each other. An extremely low energy electric igniter was used with this type of switch so that even though a small part of the charge leaked from the condenser, the remaining charge would be sufficient to fire the fuze.

The fuze was used in some shells, such as the 37 mm and some smaller bombs, such as the SD 4 and SD 10. Reference: TM 9-1985-2 (1953), pp 190-2.



DUST FUZE

Duxit (Duxite). An explosive made in Germany before WW I and placed on the British Permitted List in 1914: NG 31-33, collodion cotton 0.75-1.5, $NaNO_3$ 27-29, wood meal 8-10, Am oxalate 28-31, moisture 0 to 2.5%; max charge 12 oz, ballistic pendulum swing 2.45" vs 3.27" for British standard Gelignite containing 60% NG [E.Barnett, Explosives, Van Nostrand, N Y (1919), p 136].

Dynamit (Dynamite). According to Stettbacher (Ref 2), dynamites may be subdivided into the following groups:

a) Gurdynamit (Guhrdynamite), b) Sprenggelatine (Blasting Gelatin; c) Gelatine-dynamit, and d) Sicherheitsdynamit (Safety Dynamite)

According to Marshall (Ref 1) the following three dynamites given in Table 14 were authorized between WW I and WW II for use in German coal mines:

Table 34

Components	Dynamit		
	1	2	3
Nitroglycerin	61 to 63.5	34 to 39	16 to 22
Collodion cotton	1.5 to 3	0.5 to 3	0.5 to 2
Na nitrate and/or K nitrate	25 to 29	-	-
Na nitrate and/or Am nitrate	-	45 to 54	50 to 74
Vegetable meal	6 to 9	1 to 6	1 to 6
Soda ash or chalk	0 to 2	-	-
Nitrotoluene and/or nitronaphthalene	-	6 to 10	2 to 12
Na chloride	-	-	0 to 12

Note: According to Weichelt (Ref 3) the properties of "Dynamit 1" are as follows: temp of explosion 3600°C, vol of gases at NTP 603 l/kg, cartridge density 1.45, specific pressure 9600 kg/cm^2, veloc of deton 6350m/sec. Trauzl test value 385cc and impact sensitivity with 2 kg weight 10 cm.

Dynamit N (DN). A current dynamite suitable for use in the demolition of reinforced concrete and steel construction. Its composition and properties are given by Weichelt, as follows: RDX 70 and nitroglycol (gelatinized) 30%; temperature of explosion 4170°C, volume of gases at NTP 746 l/kg, cartridge density 1.54, veloc of detonation 8200 m/sec, specific pressure 12538 kg/cm^2.

See also Ammondynamit, Ammongelatine, Donarit Gelatine-Dynamit and Ersatzsprengstoffe.

References:

1) A.Marshall, Explosives, Churchill, London, v 3 (1932), p 109
2) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 82-90
3) F.Weichelt Handbuch der gewerblichen Sprengtechnik, C.Marhold, Halle/Saale (1953), pp 34-5, 375.

Dynammon. Dynammons are ammonium nitrate explosives used in Germany, Russia, Italy, etc:

a) Am nitrate 90 and red charcoal 10%
b) Am nitrate 95.5 and charcoal 4.5%.

Reference: A.Marshall, Explosives, London, v 2, (1917), p 493.

E-4 HEXA (Explosive). See under Ersatzsprengstoffe.

E (Series) Tanks such as E-100. See Experimental Tanks, under Panzer.

Earth-Displacement Test (Cratering Effect Test, or Mining Effect Test). In order to test the efficiency of bombs and land mines on explosion under ground, the Germans buried an item (such as a 250 kg bomb) and then exploded it. The volume of the resulting crater (in cubic meters) gave an approximate idea of the power of the explosive charge.
Reference: O.W.Stickland, PB Rept No 925 (1945), Appendix 7.

E C (Pulver). One of the sporting propellants: collod cotton 28, guncotton 26, Ba and K nitrate 38, camphor 2.0, wood pulp 4.0, moisture 1.5 and gelatinizer 0.5% [Brunswig, Das rauchlose Pulver (1926), p 134].

EDD. One of the abbreviations for Ethylenediaminedinitrate, called also DIAMIN.

Effective Calculated Calorific Values of Propellants. If it is assumed that for a certain muzzle velocity and a given projectile, the product of the charge weight and calorific value of a propellant is constant, then by knowing the calorific value and weight of a propellant, it is possible to calculate the calorific value of a second propellant of a similar nature (if its charge weight had been previously determined experimentally). For instance, if for one propellant the values were 820 kcal and 4.3 kg, and for a second propellant X kcal and 6.2 kg then:

$$X = \frac{820 \times 4.3}{6.2} = \frac{3526}{6.2} = 570 \text{ kcal/kg}.$$

This may be considered as the "effective calorific value" and it differs from the value determined in a calorific bomb, which is usually higher, e g 690-700 kcal/Kg, for the example cited immediately above.

In calculating the life of a gun barrel, it was considered preferable to deal with the "effective calorific values" than with values obtained in a calorific bomb. (See also under Erosion of the Bore and under Energy Concept of a Propellant Charge)
Reference: PB Rept 925 (1945), pp 16 & 82.

Eindrahtzünder (One Wire Electric Igniter or Primer) is described in Beyling and Drekopf, Sprengstoffe und Zündmittel, Berlin, (1936), p 220.

Einfache Zünder (Simple Igniter or Primer) is described in Beyling and Drekopf, pp 172, 174, 177.

Einheitspulver. See Standard Propellant.

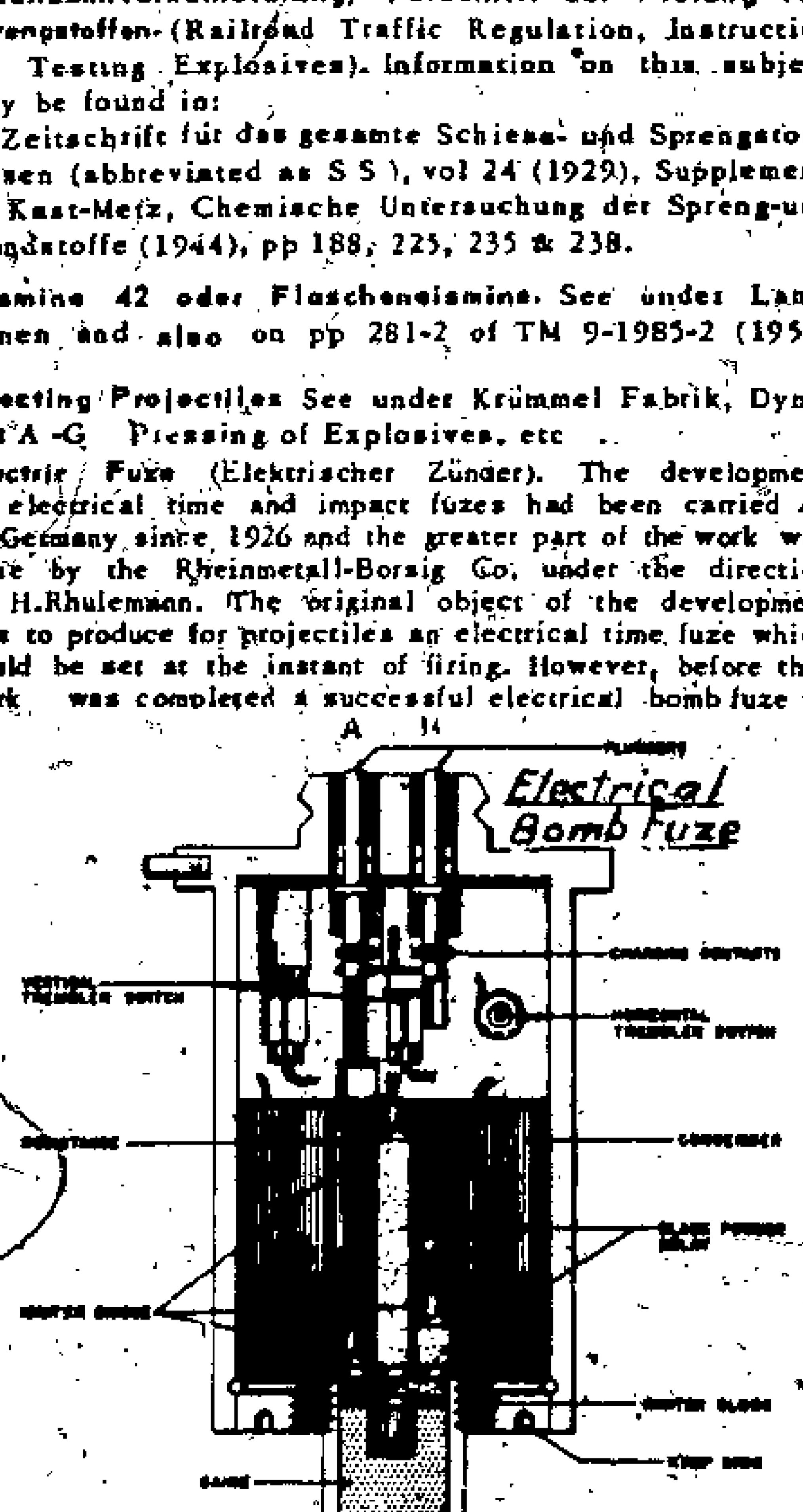
Ein-Man Torpedo. See One-Man Torpedo.

Eisenbahnverkehrordnung, Vorschrift zur Prüfung von Sprengstoffen (Railroad Traffic Regulation, Instruction for Testing Explosives). Information on this subject may be found in:
1) Zeitschrift für das gesamte Schiess- und Sprengstoffwesen (abbreviated as S S), vol 24 (1929), Supplement
2) Kast-Metz, Chemische Untersuchung der Spreng-und Zündstoffe (1944), pp 188, 225, 235 & 238.

Eismine 42 oder Flascheneismine. See under Landminen and also on pp 281-2 of TM 9-1985-2 (1953).

Ejecting Projectiles See under Krümmel Fabrik, Dynamit A -G Pressing of Explosives, etc ..

Electric Fuze (Elektrischer Zünder). The development of electrical time and impact fuzes had been carried on in Germany since 1926 and the greater part of the work was done by the Rheinmetall-Borsig Co. under the direction of H.Rhulemann. The original object of the development was to produce for projectiles an electrical time fuze which could be set at the instant of firing. However, before this work was completed a successful electrical bomb fuze was developed which was adopted in 1937 by the Luftwaffe. This was followed by several other types of electrical bomb fuzes. All these fuzes were cylindrical in shape and, with the exception of Type 5, used aluminum for the case.



The inner part of a typical fuze consisted of two sections:

a) The upper section, called the switch block, was molded polystyrene which had been machined to take various plunger contacts, the trembler switches, and in some cases the long delay igniter bridge.

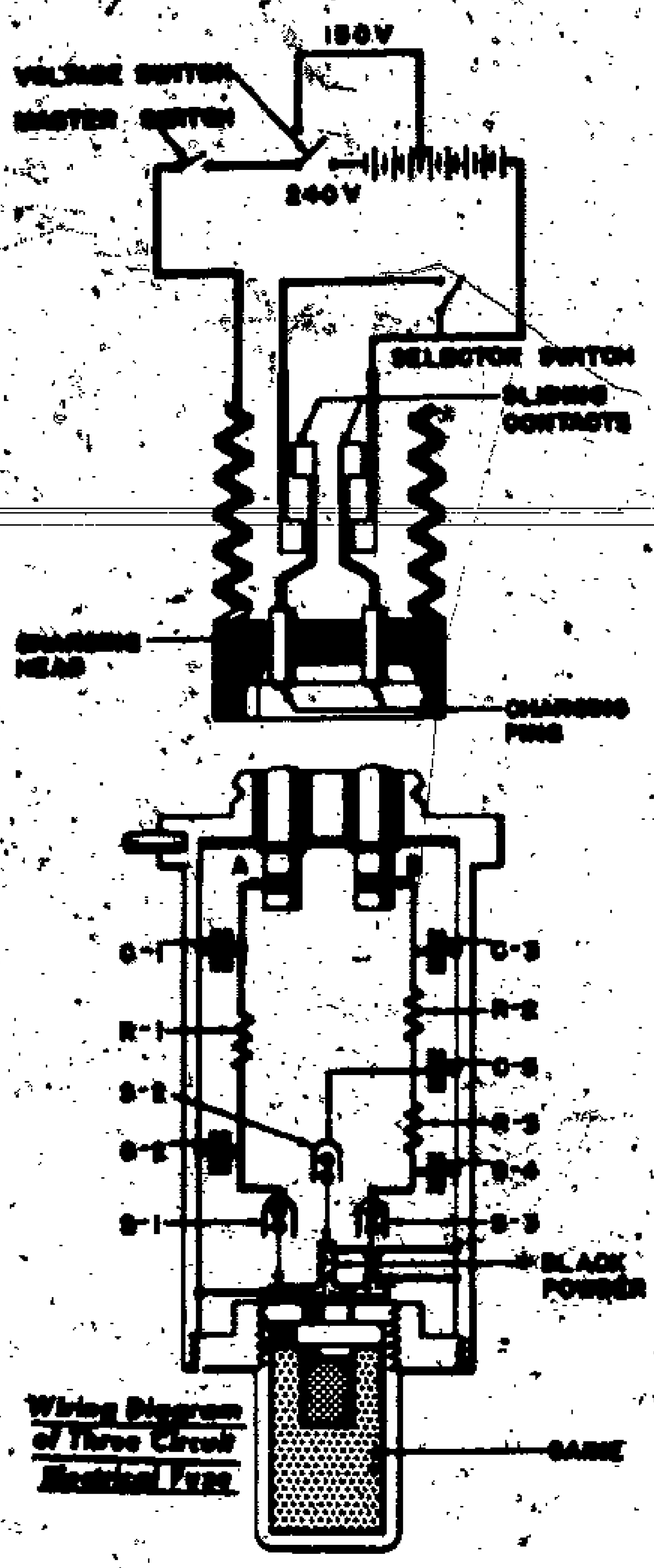
b) The lower section contained the storage and firing condensers, the resistances and instantaneous and short delay igniters. All these items were held in place by a black bitumen calking substance. The condensers were constructed of metal foil strips separated by wax paper, all wound on one cardboard cylinder. The carbon resistances were usually located inside this cylinder. Some fuzes, as for instance ElZ (9), described in this section under Aerial Burst Fuzes, contained the glow discharge tube, also called the long delay cold cathode tube. The igniter block fitted into the bottom of the fuze and contained the black powder flash pellet, the cover with three perforations leading from the pellet to the igniter bridges, and the short delay train.

The electrical bomb fuzes were either impact or time types.

Following is a brief description of operation of a three circuit electrical impact fuze illustrated on next page:

As the bomb was placed in the plane, a charging head was clamped on the fuze head. The charging pins contacted the plungers and depressed them so that they could make electrical contact with the storage condensers. The two charging pins were connected to the sliding contacts located in the charging arm. These contacts closed when the bomb had fallen from 1 to 3 inches from the rack. This prevented charging of the fuze while the bomb was still in the aircraft. The two sliding contacts were connected to the positive terminal of the 240 volt battery. The B plunger circuit was connected directly while the A plunger circuit was connected through a selector switch which had two positions: open (MV) with delay, and closed (OV) without delay. The battery was tapped at 240 and 150 volts and the two leads were run to the voltage switch. This switch was set at 150 v for level bombing and at 240 v for dive bombing, but it could not be used to open the circuit. The voltage switch was connected to the master switch which was used to jettison the bombs. The master switch was connected to the charging head which contacted the fuze head and completed the electrical circuit through the fuze body to the storage condensers.

Prior to the release of the bomb, the master switch was closed completing the circuit from the batteries through to the fuze except for the sliding contacts in the charging head. When the bomb was dropped, the charging arm was extended, causing the sliding contacts to meet for about 1/3000 of a second, the ground return circuit being through the fuze body. If the selector switch was closed, both plungers received the current and the storage condensers, C-1 and C-3, were charged. The charge of C-1 leaked slowly through the resistance R-1 into the firing condenser C-2 (The time required for the current to pass from C-1 to C-2 and build up sufficiently to fire the igniter is called the arming time). At the same time the charge of C-3 leaked through R-2 into the firing condenser C-5 and also part of the current leaked through R-3 into the firing condenser C-4. On impact, the tremblers of switches S-1, S-2 and S-3, made contacts with their cups, causing the current to flow through the igniter bridges. These were thereby heated and fired the match compositions surrounding them. When all three igniter bridges fired simultaneously the instantaneous bridge fired the flash pellet and detonated the bomb through the normal explosive train. The short and long delay trains started to burn just at the instant of detonation.



Wiring Diagram of Three Circuit Electrical Fuze

If the selector switch was held open, then the charge went through plunger-B to the storage condenser C-3 and nothing passed to the instantaneous circuit. The circuit through the resistance R-2 to the condenser C-5 became armed before the circuit through both resistances R-2 and R-3 to firing condenser C-4. If the bomb had been dropped from an altitude of less than 1170 ft, the latter circuit would not be armed before impact and the igniter bridge associated with the trembler switch S-2 would fire the long delay pellet which acting through the explosive train of the fuze would detonate the bomb. If the bomb was dropped from an altitude greater than 1170 ft, both circuits would be armed before impact, but because of the shorter delay train used in conjunction with the trembler switch S-3, the short delay would initiate the final explosive train.

Electrical time fuzes (ElZtZ) contained essentially the same basic parts as the electrical impact fuzes (ElAZ), except that the trembler switches were replaced by a vacuum tube which became conducting at a critical predetermined voltage. At the instant the bomb was started on its trajectory, an electric charge was put on the storage condenser, and another smaller charge was put on the firing condenser. The time setting of the fuze was adjusted by varying the amount of charge placed on the firing condenser. During flight, part of the charge on the storage condenser leaked through the resistor to the firing condenser. As the charge on the firing condenser increased, the voltage across the vacuum tube also increased. When the firing voltage of the tube had been reached, the firing condenser discharged through the tube and the igniter bridge thus firing the fuze.

Electrical bomb fuzes are described in Refs 1 and 3 and are listed in this work under Fuze. Some of these fuzes are described in this work under Aerial Burst Fuzes.

An electrical time fuze (ElZtZ S/30) for use in projectiles is briefly described in Ref 4, pp 605-8. Prior to firing the projectile, the fuze was charged either by hand or by a machine by putting 300 to 500 volts across the shell and an insulated contact which put voltage on the annular storage condenser. The charging could also be done by allowing the "feeler wire" (connected to the electrical circuit of the fuze) to contact the "muzzle charging ring" as the projectile was leaving the gun. A brief description of a muzzle charging ring is given in Ref 4, p 606.

A device, described in Refs 2 p 422 and 4 p 623 as the electric fuze, ERZ 39, was used for igniting the black powder charges which set off the propellant of 15 cm and 21 cm rockets. This device is briefly described in this work under Rocket Propellant Igniter.

(See also under Electrical Igniter and under Igniter).

References:

1) Anon, War Dept Tech Manual TM E9-1983 (1942), Enemy Bombs and Fuzes, File Numbers 2321.5, 2321.8, 2324.92 & 2324.93
2) Anon, Ordnance Bomb Disposal Center, Aberdeen Proving Ground, Md (No date): German Artillery Projectiles and Fuzes p 422
3) Anon, Dept of the Army Tech Manual TM 9-1985-2 (1953), German Bombs, Fuzes, Rockets, etc, pp 125-132 and others
4) Anon, Dept of the Army Tech Manual TM 9-1985-3 (1953), German Projectiles and Fuzes, pp 605-7 and 623.

Electric Fuze Primer Composition. See Primary and Initiating Compositions.

Electric Igniter (Elektrischer Zünder). Among the numerous igniters used by the Germans in mines was one type, ESMiZ 40, which used an electric current for firing the charge of a mine. This fuze is briefly described in TM 9-1985-2 (1953), pp 300-1.
(See also under Igniter).

Electric Igniters and Primers (Elektrische Zünder) Used for Commercial Explosives. These devices, described in Beyling-Drekopf, Sprengstoffe und Zündmittel (1936) may be subdivided into the following groups:

a) Einfache Zünder (Simple igniter). It consisted of a capsule (Hülse), a priming composition (Zündsatz) and electric lead-in wires connected to a bridge wire (B & D, pp 177-222)

b) Zusammengesetzte Zünder (Composite igniter or primer), such as Sprengzünder (detonating primer), consists of a simple electric igniter combined with a detonator, (B & D, pp 174 and 222-24)

c) Zünder mit fest eingesetzter Sprengkapsel consists of a simple primer into which a No 8 blasting cap (Sprengkapsel No 8) is firmly set (See B & D, pp 174 and 225)

d) Unterwasserzünder (Underwater primer) is described in B & D, pp 225-26

Zundschnurzeitzünder (Time igniter with fuse), consists of a simple primer combined with at least a 20-cm piece of fuse (B & D pp 175 and 226-29)

f) Schnellzeitzünder (Instantaneous igniter or primer), described in B & D, pp 17 and 225

g) Unterwasser-Schnellzeitzünder (Underwater instantaneous igniter or primer), described in B & D, pp 175 and 237.

Abbreviation: B & D Beyling and Drekopf.

Electric Matchhead or Fusehead is the combination of bridge wire, igniter head and lead-in wires employed in electric blasting caps and detonators.
(CIOS Rept 24-3, p 7 and also under Fusehead Manufacture).

Electric Proximity Fuze. See Proximity Fuze.

"Elefant" (Elephant). A tank destroyer known also as **Schwerer Panzer Jagd "Elefant"**. It was an improved version of "Ferdinand" (q v). See also under Panzer.

Elektronbombe (Electron-bomb). See general section.

Empfindlichkeit gegen Reibung (Sensitiveness to Friction). See general section.

Empfindlichkeit gegen mechanischen Einwirkungen (Sensitiveness to Mechanical Action). See general section.

Empfindlichkeit gegen Stoss (Sensitiveness to Shock or Impact). See general section.

Empfindlichkeit gegen Wärme (Sensitiveness to Heat), also called Chemische Beständigkeit (Chemical Stability) is described in the general section under Stability.

Energiegehalt des rauchlosen Pulvers. See Energy Content of a Propellent Charge.

Energit (Energite). According to Naoúm (Ref 1) Energit was a commercial explosive manufd after WWI by Nobel's Dynamit A-G. The explosive was prepd by wet grinding various kinds of surplus double-base propellants in "Excelsior" mills between steel discs, to a particle size of 0.5 to 2 mm, followed by drying and packing in cartridges 25 to 30 mm diameter. This explosive was used to a great extent in potash mining.

According to Pepin Lehalleur (Ref 2), Energit and Triwestfalit were industrial explosives prepared by blending a smokeless propellant (left as surplus after WWI) previously wetted with about an equal quantity of a solvent such as furfurol or acetone, with liquid aromatic nitrocompounds and oxidizing agents such as alkali nitrates or chlorates in a kneader. The strength of these explosives as determined by the Trauzl test was 330 to 350 cc, velocity of detonation 3000 to 5000 m/sec.

References:

1) P.Naoúm, Nitroglycerin, etc, Baltimore (1928), p 449
2) J.Pepin Lehalleur, Poudres, etc, Paris (1935), p 457.

[See also Nitroglycerin-Nitrocellulose Explosives (Mining Lists 33, 35 and 36) as well as Triwestfalit SN].

Energy Content of a Propellant Charge. According PB Rept 925 (1945), p 82, the energy content is equal to the charge weight of a propellant multiplied by its calorific value. For a given projectile and a given initial (muzzle) velocity, the energy content is constant and independent of the type of propellant used. For instance, if for a certain initial velocity of a projectile the charge weight of a propellant with a calorific value of 820 cal/g is 4.3 kg a propellant of 570 cal/g (such as a nitroguanidine propellant) would require a charge of 6.2 kg. (See Effective Calorific Values of Propellants).

Entflammungsprobe (Flash Test). The test as applied to smokeless propellants is described by H.Brunswig, Das rauchlose Pulver, (1926) p 304.

Entflammungspunkt oder Entflammungstemperatur (Flash Point, Kindling Temperature). The test is described in the general section.

Entkupferungsmittel. See Decoppering Agent.

Entlastungszünder (Antilifting Type Igniter with HE Charge). See under Igniter.

Entwässerung oder Trocknung (Dehydration, Drying). See general section.

Enzian Rakete (Enzian Rocket). One of the guided rockets developed and used by the Germans during WWII. It has been described by:

1) F.Ross, Jr, Guided Missiles, Rockets and Torpedoes, N Y (1946), p 43

2) A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), p 99 3) TM 9-1985-2, pp 229-32.

(See also Great Enzian or E-4 Missile).

Entzündlichkeit (Inflammability). See general section.

Entzündungsgemisch (Ignition Mixture). See general section.

Entzündungsprobe (Ignition Test). See general section.

Entzündungspunkt (Ignition or Burning Point). See general section.

Entzündungstemperatur oder Verpuffungstemperatur (Ignition, Deflagration or Explosion Temperature). See general section.

Erdstuka (Earth Stuka). A rocket-assisted 1800 kg armor-piercing bomb (PC 1800 RS) used by Stuka bombers against land targets. This bomb is mentioned, but not described, in TM E9-1983 (1942), File No 2324.92.

Erosionless Priming and Initiation (Erosionsfreie Zündung). Priming and initiating compositions containing mercuric fulminate and the chlorates (such as $KClO_3$) have been known to cause considerable erosion of gun barrels. In 1904, H.Ziegler of Switzerland, therefore, proposed that Ba salts such as the nitrate be substituted for the chlorate salts. These new compositions were known in the industry as "rostfreie Zündungen" (rust-free primers). As these substances were not entirely satisfactory, further search resulted about 1930 in the invention of compositions based entirely on organic compounds, such as Tetracene (Tetrazen). These substances, called "erosionfreien Sinoxydsätzen", were manufactured before WWI by the Rheinisch-Westfälische Sprengstoffe A-G, in Numberg.

References:
1) P.Wolf, SS 27, 397-99 (1932), Die korrosionsfreie Zündung
2) E.von Herz, ibid, 28, 37-42 (1933), Die erosionsfreie Zündung
3) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 106-107.

Erosion of the Bore (Erosion der Gewehrläufe, Rohrabnutzung oder Rohrausbrennung). Erosion of guns is described briefly in the general section.

In this section a short account is given of recent German efforts to reduce the erosion of their guns.

Due to the fact that the armor of tanks and ships during WWII was made thicker and thicker and the speed of the planes greater and greater, the muzzle velocity of guns was increased to as much as 3300 ft/sec. In order to achieve such velocities it was necessary to use propellants of high ballistic potential, such as those containing NG. As these propellants were "hot" (calorific value about 950 kcal/kg) they caused excessive erosion thus lowering the life of a gun considerably.

For instance, the life of AA guns using a 950 kcal/kg propellant was only 1700 firings and for a 820 kcal/kg propellant about 3500 firings. Even before this number of firings was reached the gun became less effective because of the escape of gases between the walls of the barrel and the projectile. This escape of gases not only reduced the chamber pressure (thus causing reduction in muzzle velocity of the projectile with consequent reduction of range and penetration) but also caused excessive muzzle flash. As the decrease in efficiency of an older gun is usually compensated for by increasing the propellant charge, this lead to a still brighter flash. In order to reduce the flash in such increased charges, more and more potassium sulfate (or other flash reducing agent) had to be incorporated. As these agents are inert materials, they diminish the efficiency of the propellant.

Erosion is the greatest factor in the wearing of the rifling of a gun, the result of which is always unsatisfactory rotation of the shell (spin) with associated fuse failure. Particularly bad erosion was obtained with high velocity guns (such as those with a muzzle velocity of about 3300 ft/sec). For them the use of propellants having calorific value of 820, or 950 kcal/kg was absolutely prohibitive and it was necessary to use cooler propellants.

Due to the fact that during the last war Germany suffered considerable shortage of steel-hardening metals, such as Cr, Ni, Mn, Mo etc required for making modern gun barrels, and due to the shortage of labor and in some cases of ordinary steel, the replacement of eroded guns was quite a serious problem. Fortunately for the Germans, a series of "cool" propellants or low calorific value propellants were developed, such as the "G" Pulver by Gen Gallwitz and the Gudolpulver by Dynamit A-G. The use of these propellants prolonged the life of a barrel to as many as 17,000 firings. This high figure was more than the Germans ever expected to achieve. As was mentioned previously, the prewar NG propellant with a calorific value of 950 kcal/kg permitted a maximum of 1700 firings, when used in AA guns. When the Germans decreased the calorific value of some of their NG powders to about 820 kcal/kg, the number of firings was increased to about 3500. Therefore, it was calculated that each reduction of about 130 kcal/kg should double the life of a gun. When Gen Gallwitz prepared his cool "G" propellants, the calorific bomb determination gave values of about 690 kcal/kg. As it had previously been found that a reduction of 130 kcal/kg doubled the life of a gun barrel, the Germans thought that the new propellants would permit about 2 x 3500 = 7000 firings. Instead of this value, they unexpectedly obtained 15,000 or even 17,000 firings. If previous German assumptions were right, then the new propellants should possess calorific values of 550 to 570 kcal/kg and not 690 kcal/kg as the calorific bomb showed. The values 550-570 kcal/kg were considered as the "effective calculated calorific values". These values were used by the Germans in preference to the calorific bomb values, such as 690 kcal/kg.

References:
1) Uto Gallwitz, Die Geschützladung, Heereswaffenamt, Berlin (1944)
2) O.W.Strickland, et al, General Summary of Explosive Plants, PB Rept 925 (1945).

Ersatzdynamit (Substitute Dynamite) is any dynamite in which a large proportion of NG is substituted by some other explosive in such a manner that the resulting composition is equal in strength to the original dynamite [P. Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), p 99].

Ersatz-Geschoss (Substitute Shell). Due to the shortage of steel and other metals, the Germans, during WWI, developed, among many other substitute ammunition items, a sort of HE-Shrapnel shell which was made of a combination of concrete and steel scrap. These shells were used toward the end of the war. [L.E.Simon, German Research in WWI, Wiley, N Y (1947), p 190].

ERSATZSPRENGSTOFFE (Substitute Explosives). Due to the acute shortage in Germany of TNT and other aromatic nitrocompounds, several substitute explosive mixtures were developed and used during WWII. Many of the "Ersatz" explosives were developed at the Krümmel Plant of Dynamit A-G others at Christianstadt and other plants.

In the preparation of various melt-loading compositions, the following trends were noticeable:

a) Substitution of RDX for part of the TNT in amatols.
b) Substitution of DNB for TNT in amatols
c) Substitution for TNT, by nitroaromatics such as dinitrodiphenylamine, hexanitrodiphenylamine, trinitroxylene, dinitronaphthalene, etc.
d) The use of low melting hydrous inorganic nitrate compounds, such as Ca, K and Na nitrates, to permit the reduction or replacement of TNT
e) The use of Al powder as an ingredient
f) The use of miscellaneous organic ingredients such as urea, PE (pentaerythritol), guanidine nitrate, ethylenediaminedinitrate, methylaminenitrate, etc
g) The use of sodium chloride (up to 60%) or of so-called "Scheidemehl" (powder consisting of a mixture of Ca and Mg silicates) in order to reduce the amount of TNT.

Most of the explosives containing these substances were much less powerful and brisant than TNT alone.

Note: From German documents, it appears that the critical period with regard to the supply of explosives and ammunition was reached in August 1944. From that date, serious shortages occurred. It was in September 1944 that on account of the shortage of NH_4NO_3, the High Command ordered the use of mixtures of 50/50 TNT/NaCl, or even 40/60 TNT/NaCl, for loading shells. However, previous to this, mixtures of 50/50 TNT/$NaNO_3$ (Sodatol) and 45/40/15 TNT/$NaNO_3$/Al had been used to a considerable extent.

Table 15

Components	Amatol			Ammonit							HEXO		HEXA			KMA Block	S-18	S-19	NaCl Explosive	TNX Explosive
	39	39a	40	H-1	H-2	H-5	H-8	43c	S-6	S-6 modif	S-19	S-22	S-22 (see note)	S-26	E-4					
TNT	50	-	-	-	-	-	-	30	40	30	-	-	-	-	-	40	-	-	40-50	80
Am nitrate	40-45	35	40	50	50	50	50	45	-	-	55	45	45	55	44	-	32	73.3	-	-
Na nitrate	-	-	-	-	-	5	-	-	-	-	9	9	9	9	10	-	6-8	17.4	-	-
K nitrate	-	-	-	-	-	-	25	-	-	-	4.2	3	3	4.2	-	-	0-2	-	-	-
$Ca(NO_3)_2.4H_2O$	-	-	-	15	15	15	-	10	-	-	-	-	-	-	-	-	-	-	-	-
RDX	5-10	15	10	25	25	20	15	-	-	-	15	14	-	-	-	-	10	-	-	-
PH - Salz	-	-	-	-	-	10	-	-	-	-	-	14	14	-	-	-	10	-	-	-
Urea	-	-	-	-	-	-	-	-	-	-	1.8	-	-	1.8	2	-	-	9.3	-	-
Al powder	-	-	-	-	-	-	-	-	10	15-25	15	15	15	15	30	10	40	-	-	-
HNDPhA	-	-	-	-	-	-	-	-	30	35-30	-	-	14	15	14	30	-	-	-	-
DNN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
DNB	-	50	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PETN	-	-	-	10	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
GuN	-	-	-	-	10	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-
DNDPhA	-	-	-	-	-	-	-	-	20	15-20	-	-	-	-	-	-	-	-	-	-
Na chloride	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60-50	-
TNX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20

Note: Composition S-22 sometimes exploded during the loading of projectiles.

Abbreviations: Am Ammonium; DNB Dinitrobenzene; DNN Dinitronaphthalene; DNDPhA Dinitrodiphenylamine; GuN Guanidine nitrate; HNDPhA Hexanitrodiphenylamine; PETN Pentaerythritol tetranitrate; PH-Salz Ethylenediamine dinitrate; RDX Cyclonite, or hexogen; TNT Trinitrotoluene; TNX Trinitroxylene.

Table 15 lists the principal "substitute explosives" used by the Germans during WWII.

To this table may be added the following:

a) An explosive composition prepd by I.G.Farbenindustrie by nitrating a mixture of MNX, methylaniline and MNT. The nitrated product consisted of TNX 45, tetryl 50 and TNT 5%
b) An explosive mixture of the Krümmel plant of D A-G contained TNT 45, Am nitrate 40 and Al powder 15%. It was suitable for cast-loading bombs, grenades and land mines
c) An explosive mixture of the Christianstadt plant of D A-G was a slurry of 70% $Ca(NO_3)_2.4H_2O$ and 30% TNT.

The following explosives, listed in the German section under their proper names, also belong to *Ersatzsprengstoffe*: Amatol, Ammonal, Ammonit, DI-Salz, Fillers Nos 13, 13a, 13-113, 19, 20, 52, 56, 57 (or Abonachit), 60, 61, 64, 70, 84 and 88, Formit, HDD, MAN-Salz, Myrol, PH-Salz, Tetransprengstoffe (TeNMe explosives), Tetramethylnitraminotetramethylmethane, TETRA-Salz, Trinitroethanol Perchlorate (see in the general section under Perchlorates) and TRI-Salz.

In addition to the explosives mentioned above, before and during WWI, the Germans developed and used several new explosives and explosive mixtures which cannot be called "substitutes" (Ersatzsprengstoffe) because they were more powerful than the previously used military explosives, such as TNT and P A. These new powerful explosives included PETN and RDX, as well as various mixtures containing these substances.

References:
1) O.W.Strickland et al, Survey of German Practice and Experience in Filling High Explosive Items, U S Office of Technical Service, PB Rept No 1820 (1945), pp 11, 15, 16, 24, 29
2) O.W.Strickland et al, General Summary of Explosive Plants, PB Rept No 925 (1947), Appendix 7.

"E"-Salz. Hexogen (RDX) prepd from formaldehyde, ammonium nitrate and acetic anhydride; see under Hexogen in this section.

Eschbachzünder oder Verzögerungszünder Eschbach [Eschbach Primer or Igniter, Delayed Action Primer of Eschbach]. It was described in Ger P 379, 939 (1922) and in Beyling-Drekopf, (1936) pp 232-35.

Note: W.Taylor et al, BIOS Final Report 644 (1945), pp 3-16 describes these devices under the terms of "Eschbach Gasless Delay Detonators" or "LT Electric Detonators".

Essigäther (Ethyl Acetate). See general section.

Essigsäure (Acetic Acid). See general section.

Etagenguss (Multiple-Pouring or Increment Loading). See general section under Loading of Ammunition.

Ethylacetanilide. See Mannol.

Ethylenediaminedinitrate (EDD). See Diamin.

Ethyleneglycoldinitrate or **Nitroglycol.** Same as Glykolnitrat.

"Eumuco" Shell Forging Press is a vertical type press which combines punching and drawing operations. It was designed and manufd by Eumuco A-G, Leverkusen-Schlebusch and used by the following plants: Krupp, Gutehoffnungshütte A-G, Sterkrade, A-G; Kieserling & Albrecht A-G, Solingen and Hasenclever A-G, Düsseldorf.
Reference: BIOS Final Rept 668 (1946).

Experimental Mine. See Versuchsmine.

Explosionsdruck (Pressure of Explosion). See general section.

Explosionskraft (Explosive Force or Power). See general section.

Explosionstemperatur oder Detonationstemperatur (Temperature of Explosion or of Detonation). See general section.

Explosionswärme (Heat of Explosion). See general section.

Explosives Developed by H.Walter et al. Between 1942 and 1945, a team of chemists under the direction of Dr Hans Walter and which included Dr Bruno Walter, developed several explosives by using methanol and ammonia as starting materials. The work was started in the Degussa Laboratories in Frankfurt on Main and was transferred to Tetschen, Czechoslovakia in 1944. The most important explosives developed by this group were MAN-Salz, Myrol and TETRA-Salz. Of these substances Walter considered Myrol as the most important, followed by the TETRA-salz and last by MAN-salz.

A few less important explosives as well as derivatives of the above three substances, and various mixtures containing them were also investigated, such as: Di-Salz, Fermit, MAN-Salz plus $NaNO_3$, MAN-Salz plus NH_4NO_3, MAN-Salz perchlorate and TRI-Salz.
Reference: H.Walter et al, German Development in High Explosives, FIAT Final Rept No 1035, PB Rept No 78, 271 (1947).

Explosive Powered Vortices. A weapon designed by Zippermeyer to be used against airplanes duplicated in miniature the effects of tornadoes. In his experiments, Z shot a projectile filled with powdered coal dust and a charge of finely grained rough-surfaced double base propellant from a mortar. When the projectile approached the vicinity of a plane the propellant was exploded by means of an initiator. The combination of the forward component of velocity of the coal particles (created by the movement of the projectile) and a lateral component of velocity (created by the explosion of the propellant) was supposed to create a sort of tornado. Such a tornado was expected to cause a plane's wing to snap off. High speed movies of this phenomenon indicated that a considerable vortex effect was achieved. The development work was not completed [L.E.Simon, German Research in WW II, Wiley N Y (1947), pp 183-4].

(See also item C under Krümmel Fabrik of Dynamit A-G).

Explosive Rivet. See Sprengniet.

Explosive Speedboats. Among the interesting inventions of WW II were small wooden boats containing large charges of explosives and designed to combat Allied shipping. When the detonating device was set, a bump against the frame-work was sufficient to set off the explosive charge. The boats always operated in packs and were accompanied by a command boat. When targets were picked, the pilot set the detonating device, locked the steering gear in position and allowed the boat to drive at top speed against the target, while he jumped overboard to be picked up by the command boat [Army Ordnance, 29 pp 378-80 (1945)].

Extra-Carbonit (Extra-carbonite). NG 35, collod cotton 0.3, Ba nitrate 4, K nitrate 25.5, tan meal 4.7, Na carbonate 0.5%; veloc of deton 4070 m/sec at d 1.20.
[E.Barnett, Explosives, Van Nostrand, N Y (1919) p 194]

Exudation (or Sweating) Test (Ausschwitzungsprobe). This test was conducted in Germany essentially as follows:

A 20-g sample of TNT, melted and cast as a cylinder 18 mm in diameter, was placed with the bottom part on a sheet of special Schleicher & Schülle filter paper resting on an aluminum plate. As a reference standard a similar pellet of Grade A TNT (s p 80.4 to 80.6°) was placed about 100 mm away. The ensemble was placed in an oven and left there for 6 hours at 72°. The diameter of the circle produced by the exudate was measured and if it was not greater than 35 mm the TNT was considered as Grade A. Any diameter between 35 mm and 70 mm was considered as Grade B (s p about 79.5°).

In addition to these two grades, the Germans manufactured Grade UK (umkrystallisiert - recrystallized) with a s p of 80.7° to 80.8°.

Note: It is interesting to note that sulfite (sellite) refined TNT required a s p of about 80.6° in order to pass the German exudation test for Grade A, while TNT produced by a nitric acid refining process, developed by Dr Wille of Allendorf Plant of D A-G, passed the Grade A test with a s p of only 80.2°. This may be explained as follows: In order to obtain a practically non-exudable TNT it is necessary to remove the bulk of the two principal impurities of crude TNT: DNT and the isomers (beta and gamma) of TNT. Of these impurities, the DNT being of low s p causes higher exudation and is the most undersirable. As these impurities adhere to the surface of crystals of alpha TNT, the simplest way to remove them is to rinse the crystals with a liquid which would either react with the impurities or dissolve them without attacking or dissolving appreciable amounts of alpha TNT. It has been claimed that while the nitric acid method removes both the DNT and the isomers of TNT, the sulfite (sellite) method removes only the isomers and leaves the DNT. The only way to remove the bulk of the DNT by the 2nd method is to use such a large amount of sellite that the DNT would be washed out mechanically together with the isomers. Such treatment would give a high s p (say 80.6°), but it is uneconomical because a significant amount of alpha TNT is removed together with the impurities. If the TNT purified by sellite has a high s p (say above 80.2°) and it still exudes, there is a possibility of the presence of some DNT in addition to isomers of alpha TNT, and other impurities. It is claimed by the inventors of the nitric acid purification process, that practically no danger of exudation exists with 80.2° TNT purified by their method because the bulk (or nearly all) of the DNT has been removed and if the s p is still lower than that of pure TNT, it is due to the presence of impurities which are less liable to cause exudation.

Abbreviation: s p Setting point (freezing point).

References:

1) C.H.Brooks, Explosives, TNT Manufacture and Development Work in Germany, PB Rept No 22,930, U S Office of Technical Services, Washington, D C (1945), p 15
2) O.W.Stickland et al, Survey of German Practice and Experience in Filling High Explosives, U S Office of Technical Services, Washington, D C, PB Rept No 1820, p 7.

Fallhammerprobe oder Fallhammerprüfung (Falling Hammer Test, Drop Test or Impact Test). See general section and also:

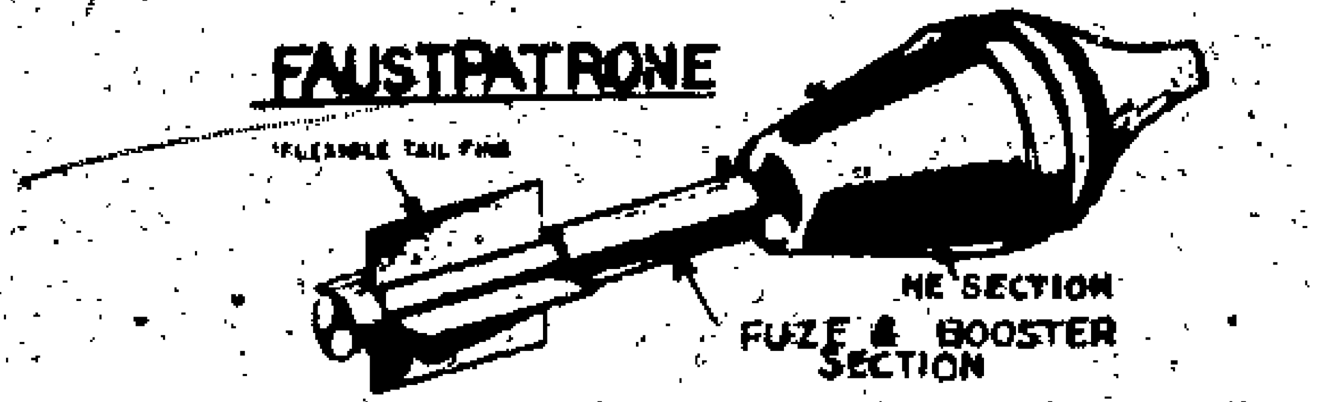
1) A.Stettbacher, Spreng- und Sprengstoffe, Leipzig, (1933) pp 371-73
2) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948) pp 118-120.

Faustpatrone (Fist Cartridge, Tank Cartridge). Hollow charge antitank rocket grenade fired from a tubular discharger. The smaller model, Faustpatrone 1 was later called Panzerfaust 30, Klein and the larger model, Faustpatrone 2, was called Panzerfaust 30 (Ref 1).

The grenade for the Faustpatrone consisted of a large war head (contg HoC-HE) and a cylindrical body (tube) terminating in a tail to which were attached four spring steel stabilizing fins. The tube contained a base fuze and a booster. The projector was a simple metal tube in which was located a propellant charge contained in a waxed cardboard cylinder held in position by a set screw. On the opposite side of the set screw was an igniter situated below a flash hole. On the top of the tube was a firing mechanism with a release button, firing pin and spring and a safety catch. A folding sight, adjustable for a range of 33 yards, was used for aiming. The grenade was armed by unscrewing the tail and inserting the booster and fuze, open ends facing each other. The fins were wrapped around the tail and the cylindrical part of grenade was inserted into the launcher tube. The pressure of the fins against the inside of the tube served to hold the grenade in position.

According to instructions furnished with the weapon, the firing mechanism was cocked first, the ensemble was placed under the right arm (the left hand supporting the forward part) and the sight adjusted to a range of 33 yards. The weapon was then fired by depressing the release button, thus allowing the striker to go forward. When the weapon was discharged, the propelling charge drove the grenade towards the target, while a portion of the gases blasted down the rear of the projector tube thereby offsetting the recoil. The back blast of the gases resulted in a jet of flame 6 to 8 ft long at the rear, which made it extremely dangerous for anyone to stand behind the firer.

The tube was discarded after firing.



The original models (Faustpatrone 30 and 30 klein) were very much feared by the soldiers assigned to use them, but the improved forms (Panzerfaust 60 and Panzerfaust 100) were safe to handle. The model 60 weighed only 13¾ lb and could be fired standing, kneeling or prone. It had as much flexibility as an ordinary rifle.

The hollow charge of the war head was capable of penetrating 8" of homogeneous armor plate and within the firing range there was no practical variation in the penetrating power.

New models were provided with heavier projectors, carrying larger propelling charge, which allowed the range to be increased to 150 meters (Refs 4 & 5)
(See also 44.5 mm Recoilless Grenade Discharger, under Weapons).
Note: Smith (Ref 5) calls Faustpatrone the "German Recoilless Grenade Discharger".

References:

1) Anon, Enemy War Materials Inventory List, SHAEF Office of AC of S, G-4 (1945), p 159
2) Anon, Intelligence Bulletin, 3, No 7, p 9 (1945)
3) A.J.Dere, The Ordnance Sergeant, Oct 1945, pp 10-11
4) L.E.Simon, German Research in WW II, J.Wiley, N Y (1947), p 188
5) Anon, German Explosive Ordnance, TM 9-1985-2, (1953), pp 399-40
6) W.H.B.Smith, Small Arms of the World, Military Service Publishing Co, Harrisburg, Pa (1955), p 522
7) G.Coghlan and H.H.Bullock, Museum of Picatinny Arsenal, Dover, N J ; private communication (1955).

"Ferdinand". A self-propelled mount consisting of 88 mm A/T gun on PzKpfw VI (P) (See under Panzer).
Note: Its improved version was known as "Elefant".

Ferro-Alloys were extensively used in war plants and for the manufacture of ammunition and weapons. One of the largest manufacturers of such alloys was the Badische Wolframerz GmbH, Söllingen.
Reference: CIOS Report No 30-55 (1945).

Ferrosilizium (Ferrosilicide or Ferrosilicon). See general section.

Feuchtigkeitsprobe (Moisture Content Test) See general section.

Feuerlilie. One of the guided missiles, developed and used during WW II. (See under Guided Missiles).

Feuerlöschmittel CB (Fire Extinguischer CB). Chlorobromomethane, CH_2ClBr. It was claimed to have been more successful as a fire extinguisher than carbon tetrachloride because it was heavier and less toxic.
Reference: CIOS Rept 25-18 (1945), p 26.

Feuerwaffe (Firearm). See under Weapons.

Feuerwerkerei, Feuerwerkerkunst oder Feuerwerkskörper (Fireworks). See Pyrotechnics.

Fichtenharz oder Kolophonium (Spruce Resin, Rosin or Colophony). See general section.

FILLER OR BURSTING CHARGE (Füllung oder Füllpulver) (Fp oder FP). Following is a list of explosives used for filling projectiles. These explosives are designated as Filler No 1, Filler No 2 etc. Some of them have prefixes such as Fp 02 which means TNT, or Fp 50/50 which means 50/50 Amatol.

Filler No 1 (Fp02). TNT pressed in cardboard or metal containers; was used for loading shells, depth charges, land mines, or for the prepn of demolition charges
Filler No 2 (Grf 88). P A pressed in cardboard or metal containers; was used in shells, land mines, depth and demolition charges
Filler No 3 (Np). PETN pressed; was used as the detonator and as a filler for grenades and small shells such as 20 to 50 mm
Filler No 4 (Fp 02). TNT loose in paper containers; was used in grenades.
Filler No 5. Granular P A ; was used as a bursting charge in stick hand grenade 24
Filler No 6. TNT/Wax - 95/5 in blocks in cardboard containers
Filler No 7 (Fp 02). TNT pressed; was used for loading shells, auxiliary boosters, bombs (heavier than 50 lbs) and chemical ammunition
Filler No 8 (Fp 02). TNT, cast; was used for loading HE shells
Filler No 10, Fp 02 + Fp 5 + Fp 10, pressed; was used

in AP shells

Filler 11. Fp O2 + Fp 10 + Fp 15 + Fp 20, pressed; was used in AP shells

Filler No 12. Fp O2 + Fp5 + RDX/Wax - 90/10, pressed in cardboard containers; was used in AP shells

Note: In the above mixtures Fp O2 means pure TNT while Fp 5, Fp 10, and Fp 20 mean TNT plus 5, 10 or 20% wax respectively. In AP shells, the filler varied with the section of the shell. The higher wax-content TNT was in the nose where the shock of impact was more intense, whereas, the booster surround consisted of pure TNT

Filler No 13 (Fp 60/40). NH_4NO_3 40 and TNT 60%; corresponds to American 40/60 Amatol. Its fragment density test gave 39 meters vs 40 m for TNT. It was cast loaded in GP, SAP and A/P bombs and shells.

Filler No 13a (Fp 50/50). Same as, 50/50 American Amatol. Its fragment density was 35 m vs 40 m for TNT; it was cast loaded in GP bombs and land mines such as Tellermine

Filler No 13-113. NH_4NO_3 70, TNT 20 and Al 10%; was used for filling GP bombs. Another mixture consisted of Am nitrate 74 and TNT 26%

Filler No 14 (Fp O2). TNT cast; was used for filling GP, SAP, AP and A/P bombs.

Note: In the pressed form Fp O2 was also used as an auxiliary booster in all HE bombs over 50 kg and as a burster in chemical ammunition

Filler No 15. TNT 90 and Al 10%; was used in the shells of mountain artillery

Filler No 16. TNT cast in an aluminum container + PETN/Wax - 90/10 as an exploder; used in some shells and as a core in submarine mines

Filler No 17. TNT/Al powder (90/10) cast + PETN/Wax - 90/10 as an exploder; uses not specified

Filler No 17A. Matrix of DNAns/Am nitrate/RDX - 54/32/14, with biscuit of Am nitrate/Ca nitrate/RDX/PETN/combined water - 46/21/20/9/4

Filler No 18 (Fp O2/H5-80/20). TNT 80, RDX 19 and Montan wax 1%; was used in some shells

Filler No 19. Am nitrate 35, TNT 55 and Al 10%; was used in some HE shells (mountain artillery)

Filler No 20. Am nitrate 53.5, EDD 45 and Al 1.5%; use unknown

Filler No 21. Am nitrate 60 and TNT 40% with a core of pressed TNT pellets

Filler No ?. TNT 35, Am nitrate 50 and DNN 15%; was used as an extender for TNT in some ammunition.

Filler No 24. Cast P A; was used as a bursting charge in some shells, as a standard burster and as a sub-booster in gaines when M.F. was used as the initiator.

Filler No 27. Fp O2 + Fp 10 (pressed); was used in AP shells and SAP bombs

Filler No 28. TNT/Wax - 90/10 + PETN/Wax - 90/10, pressed in blocks in aluminum containers; used in some HE and AP shells

Filler No 29. Fp 10 — Layers pressed in shell
Fp O2(crystallized) " " " "
Fp 10/KCl-70/30 " " " "
Fp 10/KCl-50/50 " " " "

Note: Ref 3, p 286 gives for Fp 29 the following composition: Fp 10 + TNT (crystallized) + TNT/wax/KCl-63/7/30 + TNT/wax/KCl-45/5/50 + KCl, pressed in blocks in cardboard containers.

Filler No 30. Fp O2 + Fp 5, pressed in shells.
Note: Same as under Filler No 12

Filler No 32. PETN/wax-90/[illegible] pressed in wax paper;
Filler No 33. PETN/wax-85/[illegible] were used in A/T mines and as standard sub-boosters in all kinds of ammunition

Filler No 34. PETN/wax-70/30 was used as filler of special shells

Filler No 36. PETN/wax-60/40; was used as filler of special shells

Filler No 37. PETN/wax-50/50; used as above

Filler No 38. PETN/wax-35/65; used as above

Filler No ?. PETN 91.5, wax 8.5%; was used as sub-booster in bomb gaines, in 80 mm CM shells and in some 50 mm and 37 mm shells

Filler No ?. PETN/wax-82/18; was used in 37 mm APRN and APMB shells

Filler No ?. PETN/wax-87/13; was used in 88 mm HE shell

Filler No ?. PETN/wax-92/8 ± 2%; was used in A/T Mk1 50 mm TM, 105 mm HE How as a detonator surround in HE shells (50 and 75 mm) and in some 75 mm and and 88 mm AP shells

Filler No 42. Pentol (pressed); was used in HE shells.

Filler No 43. Plastic explosive consisting of PETN and mineral oil; was used in some HE shells

Filler No 45. PETN/RDX-50/50, plus 30% wax; similar in properties to PETN/wax-70/30; was used in some special projectiles. Another mixture contained RDX 50, PETN 35, and wax 15%

Filler No 52. An amatol-type explosive containing DNB 50, NH_4NO_3 35, and RDX 15%; yellow solid; could be cast; explosive properties similar to those of 50/50 amatol; toxic (due to the presence of DNB). Was used in 50 kg GP and SAP bombs. (Ref 1, p 133)

Filler No 52a. An amatol-type explosive containing tech Ca nitrate 30, NH_4NO_3 55, RDX 15%; was less powerful and brisant than 50/50 Amatol but of about the same sensitivity. Was used as a biscuit filling in the nose of parachute and robot bombs, with a surround of Filler No 52a

Recognition Handbook (Ref 3, p 286) gives the following compositions for Fillers No 52 and 52A:

Filler No 52. Matrix DNB/Am nitrate/RDX - 47/38/15, with a biscuit of Am nitrate /Ca nitrate/RDX/PETN/Combined water - 46/21/20/9/4

Filler No 52A. Matrix DNB/Am nitrate/RDX - 50/35/15, with a biscuit of Am nitrate/Ca nitrate/RDX/PETN/Combined water - 46/21/20/9/4

Filler No 52A. Matrix DNB/Am nitrate/RDX - 53/30/17, with a biscuit of Am nitrate/Ca nitrate/RDX/PETN/Combined water - 46/21/20/9/4

Filler No 56 or Donarit. Am nitrate 67-80, TNT 12-25, NG 3.8, collodion cotton 0.2 and vegetable meal 4%. It was a yellow, semi-plastic substance possessing nearly the same explosive properties as 80/20 amatol, except that it was slightly more sensitive to impact and rifle bullet tests. It was used for filling some hand grenades (Ref 1, p 90)

Note: Ref 3, p 287 gives the following composition for Filler No 56. Am nitrate 80, TNT 12, NG 4 and rye flour 4%

Filler No 57 or Ammonchit 2. Am nitrate 64, K or Na nitrate 3, TNX 13, collodion cotton 1, and Na-chlorate 19%; was used in some grenades

Note: Ref 3, p 287 gives the following composition for Filler No 57. Am nitrate/alkali nitrate/TNT/alkali chloride/collodion cotton/charcoal - 64/3/14/17/1/1. This composition was called Monachit.

Filler No ?. RDX 8, tech Ca nitrate 5, Am nitrate 55, EDD 30 and wax 2%, white substance; used in some

ammunition (cast loaded). Its explosive properties were comparable to 50/50 Amatol (Ref 1, p 134)

Filler No 60. Pressed TNCB; was used as a shell filler

Filler No 61. Cast TNCB; was used as above

Filler No 64. Cast-loaded mixture of TNCB 60 and Am nitrate 40%; white to brownish color, m p 81-82°, partially sol in w, sol in alc and acetone; explosive properties were similar to 40/60 Amatol; hygroscopic and unstable, very toxic; was used as a shell filler (Ref 1, p 114)

Filler No 66. PETN/wax - 50/50

Filler No 70. Pressed TNB; was used in some primers

Filler No 83. EDD in mixtures with some HE, to permit cast loading

Filler No 84. EDD 55 and Am nitrate 45%; was used in some shells

Filler No 86. EDD/RDX/Wax - 46/18/36, pressed in blocks wrapped in wax paper and placed in an aluminum container

Filler No ? (Fp 30/70). TNT 30 and Am nitrate 70%; was used in some A/P bombs

Filler No ? (Fp 5/95). TNT 5 and Am nitrate 95%; use is not known

Filler No 88 (Fp 40/60). NH_4NO_3 60 and TNT 40%; was used in some shells grenades and radio-guided bombs

Filler No 89. General name of cast mixtures based on RDX

Filler No 90. General name of pressed mixtures based on RDX

Filler No 91-H5. RDX 95 and Montan wax 5%; was used in sub-boosters and boosters

Filler No 92-H10. RDX 90 and Montan wax 10%; was used in boosters

Filler No ? (H 10.3). RDX 89.7 and Montan wax 10.3%; was used in 75 mm AP shells

Filler No ? (H 3). RDX 97 and Montan wax 3%; was used in boosters for tropical countries, to replace PETN/wax mixtures

Filler No 95 (H/Fp O2). RDX 60 and TNT 40%; was used in some shells (press-loaded)

Filler No 101 (Fp 15). TNT/wax-85/15%; was used in AP bombs (Ref 2 gives for Filler 101. TNT 92 and Montan wax 8%)

Filler No 102. Am nitrate 60, TNT 40% and some wax; uses not indicated

Filler No 104. RDX; uses not indicated

Filler No 105 (Trialen 105). RDX 15, TNT 70, and Al (powder) 15%; was used cast-loaded in GP bombs and torpedoes. Another mixture contained TNT 74, napthalene 14 and Al 12%

Filler No 106 (Trialen 106). RDX 25, TNT 50 and Al 25%; was used in some bombs

Filler No 107 (Trialen 107). RDX 20, TNT 50 and Al 30%; was used in underwater ammunition

Filler No 108 (?) (Tritolital). RDX 20, TNT 60 and Al 20; was used in underwater ammunition

Filler No 109 (Trialen 109). RDX 70, Al 25 and Montan wax 5%; was used, compressed in pellets, as a biscuit filling with NGu in the nose and as a surround for Filler No 106 (Trialen 106) in the 500 kg GP, 1800 kg AP bombs and in some pilotless aircraft missiles.

Note: NGu was used as protection for Filler No 109, which alone is even more sensitive than straight RDX.

Filler No 110. Am nitrate 90, Al 2.5, napthalene 5 and wood meal 2.5%; light gray in color; required a secondary HE primer to detonate; was used, press-loaded in concrete and in A/P bombs

Filler No 111. Am nitrate 90, carbon 6 and mineral matter 4%; was used press-loaded in some bombs.

Note: Ref 3, p 288 gives for Filler No 111 Am nitrate 96 and carbon 4%

Filler No 112. Am nitrate 80 and TNT 20%; was used in some bombs

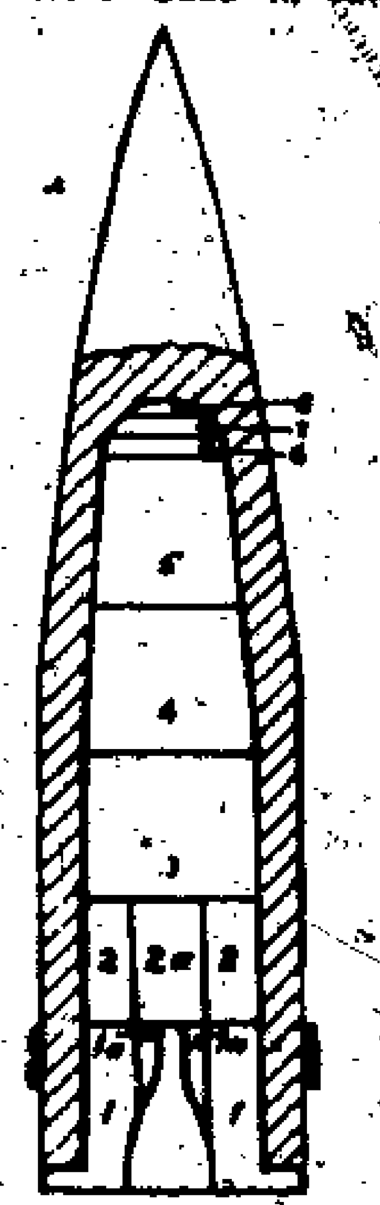
Filler No. 113. Am nitrate/TNT/Al powder - 70/20/10; uses not indicated.

Abbreviations: Al Aluminum; alc alcohol; Am Ammonium; AP Armor-piercing; A/P Antipersonnel; A/T Antitank; CM Chemical mortar; DNN Dinitronaphthalene; EDD Ethylendiamine dinitrate; GP General purpose; H Hexogen (RDX); HE High-explosive; HoC Hollow (shaped) charge; How Howitzer; L A Lead azide; L St Lead styphnate; MB Monoblock; M F Mercuric fulminate; Mk Mark; NGu Nitroguanidine; P A Picric acid; PETN Pentaerythritol tetranitrate; RN Round nose; RDX Cyclonite or Hexogen; SAP Semi armor-piercing; sol soluble; tech technical; TM Trench mortar; TNB Trinitrobenzene; TNCB Trinitrochlorobenzene; TNT Trinitrotoluene; TNX Trinitroxylene; w water

References:
1) Allied and Enemy Explosives, Aberdeen Proving Ground, Maryland (1946), pp 75, 79, 82, 86, 88, 97, 112, 113, 118, 120, 122, 124, 129, 133, 134, 137, 139, 141, 142 and 147
2) US Department of the Army Technical Manual TM 9-1985-3 (1953), pp 556-7
3) Anon, Recognition Handbook for German Ammunition, Supreme Headquarters Allied Expeditionary Force (1945), pp 286-8.

Fillers Used in Anticoncrete and Armor-Piercing Shells. In order to make the explosives such as TNT safe for use in armor-piercing and anticoncrete shells, sections of TNT close to the nose were made less sensitive to shock by incorporating some wax and K chloride.

A good example of this type of filling was the one in 210 mm Anticoncrete Shell (21 cm GrBe). Its filler consisted of ten pressed pellets placed in cardboard container and held in position by a cement lining. The forward three sections 6, 7 and 8 were intended to provide protective layers, practically insensitive to shock whereas the layers close, to the base were nearly or just as sensitive as straight TNT. The enclosed list gives the compositions and weights of charges shown on the the enclosed drawing.



No 1	4 lb, 2 oz of TNT/Wax - 94/6
No 1a	8 oz of Straight TNT
No 2	4 lb, ¼ oz of TNT/Wax - 90/10
No 2a	1 lb, 5½ oz of Straight TNT
No 3	5 lb, 5½ oz of TNT/Wax - 90/10
No 4	5 lb, 4½ oz of TNT/Wax - 91/9
No 5	4 lb, 2 oz of TNT/Wax - 91/9
No 6	6 oz of TNT/Wax/K chloride-60.5/5.4/34.1
No 7	5 oz of TNT/Wax/K chloride-44.1/5.6/50.3
No 8	6 oz of K chloride

Total weight of filler was 25 lb 8¼ oz

Reference: E. Englesburg, The Ordnance Sergeant, May 1944, p 320.

Firing or Igniter Composition 121. One of the mixtures used during WWI: silicon 25, Pb chromate 50, and K chlorate 25% [PB Rept 95.613 (1947), Section U].

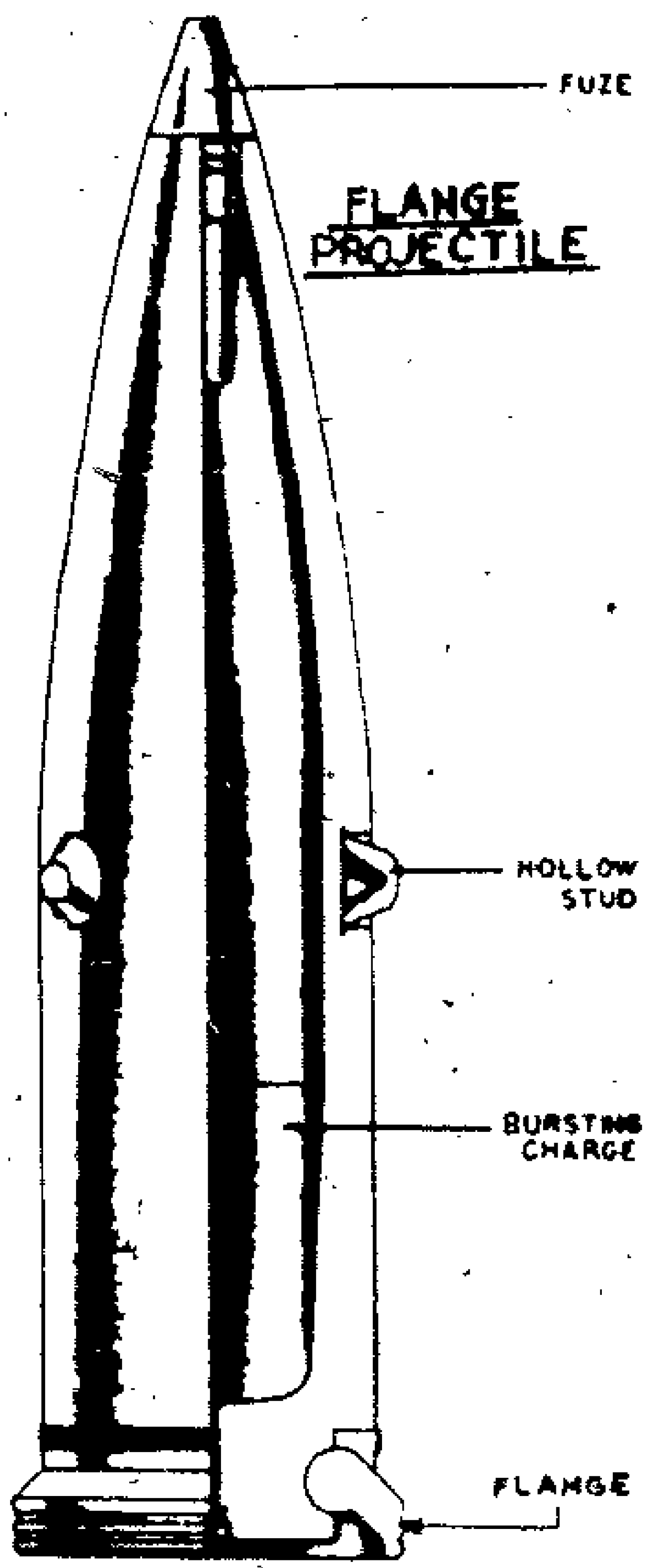
Flammbombe. An incendiary bomb containing an oil mixture and a HE bursting charge. The following types are described in TM 9-1985-2 (1953), pp 52-54:

a) Flam C 250 A (B or C) contained 50 kg of oil incendiary mixture and TNT bursting charge (p 52)
b) Flam KC 250, same filling as above (p 53)
c) Flam C 500 contained the incendiary oil consisting of 70% petroleum and 30% TNT, with TNT bursting charge (p 54).

(See also Incendiary Bombs, Brandbomben and Sprengbomben). (Illustrations are given under Bombs).

Flammability Test (Entzündlichkeitsprobe). A special apparatus called "Flammenpendel" and its application to testing of various explosives and pyrotechnic compositions was described by F.Lenze SS 27, 366-69 (1932).

Flammenauslöschendzusatz (Flame Extinguishing Addition or Flame Reductant). See Flash Reducing Compounds in the general section.



Flanschgeschoss (Flange Projectile), called also "Squeeze-bore", or "Littlejohn" was a subcaliber projectile provided with a flange and three hollow studs as shown on Figure and described in the TM 9-1985-3, p 360.

It was fired from a cylindrical rifled barrel to which a smooth-bored, tapered muzzle extension was attached.

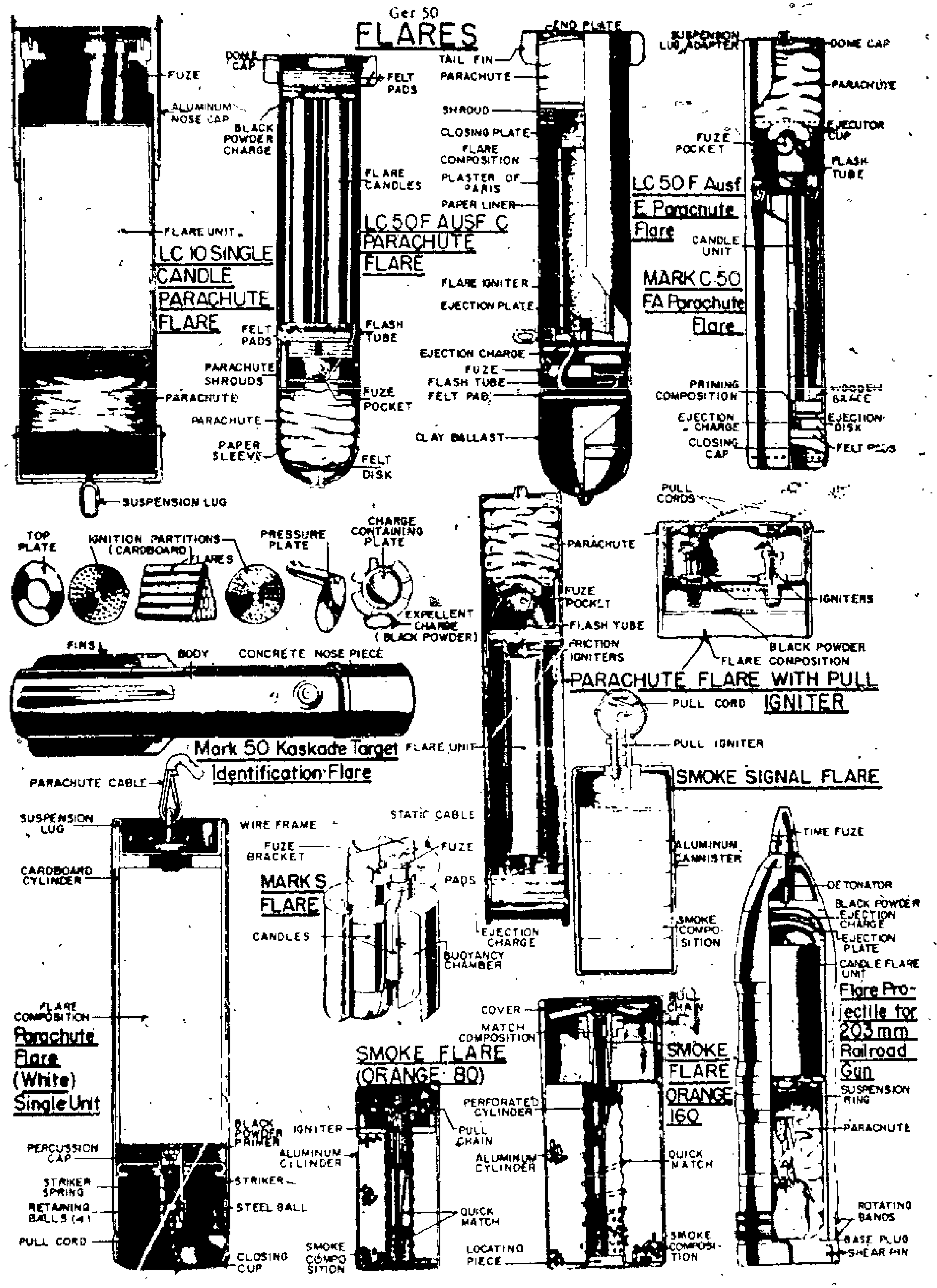
The principal advantage of the "flange" projectile in comparison to the other subcaliber projectiles was that it had no parts to be discarded, because the hollow stud and the flange were easily depressed when the projectile passed from the rifled section of the gun to the smaller caliber smooth bore extension.

(Compare with Arrowhead Projectile, Arrow or Needle Projectile, Disintegrating Band Projectile, Röchling Projectile, Sabot Projectile and Tapered Bore Projectile)

Flare (Leuchtkugel oder Fackel). A German flare usually consisted of a cylindrical container housing an illuminating element. Upon being ignited by a pull friction igniter or a time fuse the flare burned vigorously producing intense light and heat. The illuminating element consisted either of a single or a multiple candle unit which varied in intensity of illumination and color. Flares were made with or without parachutes.

A brief description of the following flares is given in TM 9-1985-2 (1953), pp 65-81:

1) LC 10 (Leuchtcylindrisch 10) consisted of an aluminum cylinder, a single candle in a cardboard liner, an "89" clockwork fuze and a parachute located in the tail end. The flare was dropped from a plane and at a predetermined time the fuze fired and ejected the candle and its parachute from the body. Simultaneously the candle was ignited (p 65)
2) FB 50, Single Candle Parachute Flare (p 66)
3) LC 50F Ausf C Parachute Flare consisted of an aluminum cylindrical body with dome-shaped nose attached by means of brass screws. On releasing the flare, the pyrotechnic delay (inside the fuze) was ignited. This fired the quickmatch, which in turn burned through the flash tube and ignited the black powder charge in the tail. The pressure of the gases developed by the deflagrating black powder, caused all four flare candles and the parachute to be expelled through the nose, after shearing the holding screws. Simultaneously, the candles were ignited through perforations in the ejector plate. The composition of the candle was Ba nitrate 75.8, Al 16.5 and S 7.7%. The burning time was slightly over 5 min and the candlepower 216,000 (p 68)
4) LC 50F Ausf E, Single Candle Parachute Flare (p 68-9)
5) LC 50F Ausf G, Single Candle Parachute Flare (pp 69-70)
6) Mark C 50 F/A Parachute Flare consisted of a cylindrical aluminum housing containing a parachute, fuze, quickmatch, single candle unit, flash tube, priming composition and ejection disk. When the flare was released, the aerial burst fuze started to function. The flash ignited the quickmatch and the flame was transmitted through the flash tube to the tail end to ignite the ejection disk of black powder. The pressure of the gases developed by the burning powder expelled the parachute and the candle through the nose. Simultaneously the primer composition and the candle were ignited (pp 70-1)
7) Mark 50 Kaskade Target Indicating Flare consisted of a sheet metal cylindrical container 7.7" diam and 41.0" long containing 62 flares (in three layers separated by perforated cardboard partitions), an expelling charge of black powder, smokeless propellant ignition disks and an igniter (fuze) assembly. A heavy concrete nose was provided to make the missile fall with the nose downwards, when released from a plane. As the missile fell, the expelling charge was ignited thus ejecting the flares (candles). At the same time the propellent



ignition disks ignited each candle. (Composition of candles is given under Pyrotechnics [See also BIOS Rept 1233 (1946), p 1]
8) Single Candle Parachute Flare with Pull Igniter was similar in construction to the Mark C50F/A flare. The principal difference was that the candle was reversed and ignited by pull (friction) igniters instead of by a black powder charge. After the flare was released from the aircraft, the fuse (through the flash tube) ignited the ejection charge of black powder and the pressure of the gases ejected the parachute and the candle through the nose. At the same time the parachute pulled the cords of the igniters, which were provided with delay elements of 3½ sec. The candle was then ignited and burned for 5 minutes (pp 73-5)
9) Single Candle Unit Parachute Flare (White) consisted of a cylindrical aluminum body which was attached to a parachute by means of a cable. Eight shroud lines terminated in a loop which was in turn attached to the pull cord of the igniter. On releasing the flare, the parachute exerted a pull on the igniter "31" firing cord thus releasing the striker spring. Then the striker hit the percussion cap igniting the black powder primer and the candle (pp 74-5)
10) Single Candle Parachute Flares, I (White) and II (Red) (pp 75-7)
11) Mark 5 Flares, Types 1 and 2 consisted of a cylindrical buoyancy chamber which contained two candles. To these were attached a fuse, a static cord and a pull igniter. The static cord functioned either the arming device of the fuse or the pull igniter. When the device was released (from a container) over the water it went under the surface and then came up. It floated with the head of the flare just clear of the water. When the 1st candle was about ½ burned out, a piece of safety fuse running to the 2nd candle was ignited and, after a short delay, the 2nd candle started to burn. Each candle burned for about 2½ min (p 77-8)
12) Smoke Flares: Orange 160 and Orange 80 were used as wind drift indicators (pp 79-80)
13) Smoke Signal Flare, used as navigation aids by pilots (p 80)
14) Smoke Signal Flare ARDR was used for the same purpose as above (p 80)
15) Distress Signal Torch consisted of a narrow sheet aluminum cylinder containing three pressed charges of flare compositions which burned respectively red, white and red. The compositions were ignited by a pull igniter (p 81)
16) Ground Flare, Bodenleuchte (P) F156 217 is briefly described in BIOS Final Report 1733 (1946), p 2 and the composition of the flare is given under Pyrotechnics.

In addition to flares dropped from planes, there were some flares fired from guns, e g the Flare Projectile for the 203 mm Railway Gun (20.3 cm Leuchtgranate) described in TM 9-1985-3 (1953), pp 519-20. The shell was conventional in design except that it had an additional bourrelet machined near the middle of the shell body. The weight of the shell was 226¾ lb, that of the flare candle unit and parachute assembly 47 lb, and of the expelling charge (black powder) ½ lb. The flare and parachute were expelled through the base of the shell.

Flash Reduction in Propellants (Mündungsfeuerverminderung oder Mündungsfeuerdämpfung). In order to reduce the flash produced on combustion of propellants, the Germans for many years used the salts of potassium, such as K sulfate K nitrate, or K oxalate. The investigation conducted before WW II has shown that of the inorganic compounds the best flash reducers are the alkali salts and that flashlessness is improved on going up the series in the Periodic System. (Cs is better than Rb and Rb is better than K).

The inorganic flash reducers (such as K sulfate) were usually loaded in small bags separately from the propellant, and placed between the projectile and the propellant. These anti-flash bags, called in German "Vorlage", consisted of two perforated discs of artificial silk or cotton cloth sewed together in the form of "doughnuts" and filled with coarsely pulverized K sulfate. (Ref 1, p 324).

Another flash reducer consisted of a large bag with oxalic acid and a small bag with potassium oxalate.

With the incorporation during WW II of nitroguanidine (NGu) in some propellants (see Gudolpulver), it was found that NGu alone gave sufficient flashlessness without incorporating any of the usual flash reducing agents. In propellants which did not contain NGu, flashlessness could be successfully achieved by using a small bag with NGu and a small bag with K nitrate.

It should be noted that the use of inert (non-explosive and non-combustible) flash reducers such as K sulfate, nitrate, or oxalate, oxalic acid etc, is always bound to decrease the ballistic potential of the propellant and their use in large amounts should be avoided. This does not apply to NGu because this compound is not inert but is an explosive. For this reason, much larger amounts of NGu may be used, either directly incorporated in a powder, or used in a separate bag.

The following German flash reductants were examined at Picatinny Arsenal (Ref 3) during WW II:

a) Potassium chloride; was used in 76.2 mm AP weapons
b) Potassium sulfate; was used in 7.92 Ball, 20 mm APHV, 20 mm Inc, 20 mm HE Mauser, 20 mm Solothurn, 37 mm APHV, 37 mm APHV, 37 mm APMB, 37 mm HE, 50 mm HE, 75 mm AP, 75 mm HE and 100 mm K18 weapons
c) Sodium bicarbonate; was used in some 88 mm AP guns
d) Sodium sulfate: was used in some 75 mm HE guns.

According to Ref 4 the following compounds were examined at the Düneberg Fabrik Dynamit A-G as possible flash reducers (Flammendämpfer):

Aminoguanidine bicarbonate Am acetate, Am phosphate, Am sulfate, apatite, asbestos, Ba sulfate, boron nitride, cerium oxide, cryolite, dicyandiamide, dimethyl oxamide, dimethyl urea, disodium phosphate, mercurous nitrate. methylene urea, K bicarbonate, K chloride, K iodide, K metaphosphate, K perchlorate, K phosphate, K silico-fluoride, K urea oxalate, sodium ammonium sulfate, sulfur, zinc sulfate and Zr oxide.

It was claimed that methylene urea reduced the flash to a far greater extent than any of the organic compounds used. It was also stated that cerium salts were much more effective than any other metallic salts investigated (Ref 5).

Abbreviations: AP Armor-piercing; HE High-explosive; HV Hyper velocity; MB Monoblock; Inc Incendiary.

References:

1) Davis (1943), p 324 2) O.W.Stickland et al, General Summary of Explosives Plants, PB Rept 925 (1945), Appendix 8 3) Picatinny Arsenal Tech Rept 1555 (1945), p 31
4) A.A.Swanson & D.D.Sager, CIOS Rept 29/24 (1946), p 6
5) CIOS 29-24 (1946), p 6.

Flash Reduction in Projectiles. When it was required by the German High Command to have an AA (Flak) projectile whose explosive flash is practically invisible in the night sky, the Krümmel Fabrik A-G satisfied the requirement in the following manner:

The high explosive filling was completely surrounded with a 5 - 6 mm thick layer (sheath) of chlorine atom containing material such as tetrachloro- or hexachloronaphthalene or Am chloride.

Reference: PB Rept 925 (1945), Appendix 7.

Flüchtigkeit (Volatility). The determination of volatility of explosives is described in the analytical section.

Fluorine and Fluorides. See general section. The methods of manufacture, as practiced at the IG Farbenindustrie plants at Leverkusen and Oppau, are briefly described in BIOS Final Rept 1595 (1951).

Flüssige Tri (Liquid TNT). See Drip Oil in the general section and Tropföl in the book by Stettbacher, Schiess- und Sprengstoffe (1933), p 240.

Flüssigluftsprengstoffe (Liquid Air Explosives, Oxyliquit). See general section.

Fog Acid (Smoke-Screen Agent). See Nebelsäure.

Föhn Gerät, Föhn RZ 73. See RZ 73 Föhn and also TM 9-1985-2 (1953), p 235.

Fördit (Foerdite). According to Naoúm, Nitroglycerin, Baltimore (1928), pp 407, 411, Foerdites were permissible gelatin-dynamites manufd after WW I. Their composition is given in Table 16.

Table 16

Components and properties	Designation		
	Fördit 2	Fördit 1	Fördit 4
Am nitrate	41.0	37.0	38.0
NG (nitroglycerin)	29.9	25.5	21.0
Collod cotton	1.0	1.5	1.0
MNT (mononitrotoluene)	3.5	5.0	5.0
Glycerin	8.7	3.0	3.0
Cereal or potato flour	-	-	12.0
K chloride	22.0	24.0	19.0
Am oxalate	-	-	1.0
Bolus (china clay)	0.1	-	-
Dextrin	0.7	4.0	-
Oxygen Balance, %	-	-	-19.5
Trauzl Test value, cc	-	-	220

Formit (Formite). One of the Ersatzsprengstoffe developed during WW I by an explosive group under the direction of Dr Hans Walter. It was obtained by heating a mixture of 30% commercial formaldehyde and NH_4NO_3 (in the ratio 6 mols HCHO to 8 mols NH_4NO_3) under reflux for about 1 hour, followed by vacuum distillation to remove the water and unreacted formaldehyde. The residue was a faintly yellow composition which consisted of MAN-Salz 25 to 30, TRI-Salz 1 to 3 and Am nitrate 67 to 74%. Its calorific value was 900 kcal/kg and volume of gases produced on explosion 1050 l/kg (calculated at 0° and 760 mm Hg). When about 15% of RDX or PETN was incorporated, the velocity of detonation was increased appreciably and the brisance was increased to that of TNT, while the volume of gases evolved on explosion was higher than for TNT. This explosive could be cast-loaded (setting point about 90°) in projectiles but unfortunately it exuded at 60-70°. It was fairly stable to heat, provided no iron impurities were present.

References:

1) H.Walter et al, German Developments in High Explosives, PB Rept No 78,271 (1947), p 4; 2) A.LeRoux, Mém Poud, 34, 132 (1952).

Four-Cartridge Test, designed to determine the ability of mining explosives to transmit detonation, called in German Detonationsfähigkeit Probe, was conducted as follows:

Four cartridges, 35 mm in diameter, were laid end to end on a bed of sand and one side of the train was detonated by a No 3 blasting cap. It was required that all four cartridges be detonated completely.

Reference: BIOS Final Rept 1266 (1947), p 2.

Fp (Füllpulver) Any explosive used for filling shells, bombs, etc.

Fp 60/40 (Füllpulver 60/40 Amatol containing TNT 60 and Am nitrate 40%.

Fp 02 (Füllpulver 02): Explosive, pattern 1902 (TNT).

Fp 88 (Füllpulver 88). Explosive, pattern 1888 (P A.).

Fragment Density Test, Fragment Concentration Test or Density of Splinters Test (Splitterdichteprobe). A series of investigations were conducted during WW II by the German Ordnance Dept (Waffenamt), under the direction of Dr G. Römer in order to determine the relation between effective fragment (splinter) weight, fragment velocity, fragment number and fragment range (distance of travel) and the weight and type of the explosive material, as well as the type and thickness of steel used in ammunition. These tests were conducted with a view to designing the most effective ammunition. One of the tests used for this purpose was the fragment density test (density of fragment test), which was conducted in the following manner:

A shell containing an explosive to be tested was detonated while surrounded with wooden boards 2 cm thick. The number of fragments per square meter piercing the boards was counted and the average distance at which there would be one fragment per sq m was calculated from a specially constructed curve. In order to obtain reliable results it was necessary to detonate at least 10 shells.

Following are some values for the average distance to obtain one penetration per square meter using a 105 mm shell:

TNT 39-40 m, 40/60 - Amatol 38-39 m, 50/50 - Amatol 35 m, 60/40 - Amatol 34 m, 50/50 - TNT/NaCl 26 m and 40/60 - TNT/NaCl 23 m.

Note: As this method was expensive and time consuming, the Krümmel Factory of Dynamit A-G proposed loading an iron tube with an explosive to be tested and to detonate it on lead. No details of the last method were given.

References:

1) O.W.Stickland et al, General Summary of Explosive Plants, PB Rept No 925 (1945), Appendix 7 2) G.Römer, PBL Rept 85 160 (1946) and private communication Dec 12, 1953.

Friction Type Igniter (Brennzünder). See under Igniter.

Friedler of Halberstadt in 1893 patented an incendiary composition which burst into flame on contact with water. It consisted of metallic sodium or potassium incorporated in a mass of crude rubber. The mixture was loaded in thin walled projectiles which being lighter than water floated on its surface [Daniel, Dictionnaire (1902), p 310].

Fritsche Zündschnur (Fritsche's Fuse). A core consisting of a pressed mixture of K nitrate 63, alderwood charcoal, (Erlenholzkohle) 13, and pulverized sulfur 24% enclosed in a fabric tube. It was slow-burning. [A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 107].

F-Stoff (Titanium Tetrachloride). See general section; was used as a smoke-producing agent.

Fuel Oil Igniters (Diesel Igniters) were sticks of wood 4" x 1/4" x 1/16" which were dipped, first in acetone-celluloid solution and then in the following pyrotechnic mixture: Al 30.6, Ba nitrate 26.3, K nitrate 23.0, S 5.0 and gum 6.9%. In order to make the match friction sensitive, one end of the stick was coated by dipping it into a mixture containing K chlorate 66.9, Fe oxide 14.9, powdered glass 6.0 and gum 12.2%.

On striking, these igniters burned fiercely. It is believed that they were used for igniting fuel oil in power houses.

Reference: T.M.Bennett, BIOS Final Rept, 1313 (1947), pp 5-6.

Füllpulver (Fp) oder Füllung (Filler or Filling Explosive). See Filler.

Füllstoffe (Filling Materials). Non-explosive materials, such as NaCl, chalk, etc., incorporated in dynamites and other explosive compositions either to change the characteristics of explosives (such as to make them less brisant) or to economize on the amount of NG, TNT, etc.

Dynamites containing Füllstoffe were called Gestreckte Dynamite (Stretched dynamites) [Naoúm, Schiess- und Sprengstoffe (1927), p 100].

Fulmenit (Fulmenite). Fulmenites were Favier-type explosives such as: a) Am nitrate 86.5, guncotton 4, TNT 5.5, paraffin oil 2.5 and charcoal 1.5% (Ref 1), b) Am nitrate 82.5, guncotton 4, TNT 11, charcoal 1.5 and paraffin oil 1% (Ref 2).

References:

1) Marshall, v 1 (1917), p 391 2) E.Barnett, Explosives, Van Nostrand, N Y (1919), p 113.

Fulminante Stoff (Fulminating Compound). Under this name, Stettbacher, Spreng- und Schiesstoffe (1948), p 119, lists the following substances: Jodstickstoff, (Nitrogen iodide), Knallsilber von Bertollet (Fulminating silver of Bertollet), Nitrodiazobenzolperchlorat (Nitrodiazobenzene-perchlorate) and Knallsilber (Silver fulminate).

The initiating compounds, such as M F, L A, and L St, are listed in the same book as Zündstoffe.

Fulminatin. An explosive proposed by Fuchs of Silesia: NG 68, and wool shearings (clippings) 32% [L.Gody, Traité des Matières Explosives, Namur (1907), p 359].

Fulminatschnur (Fulminate Fuse) is a detonating fuse which has a core of mercuric fulminate desensitized with paraffin. Its velocity of detonation is 5300 m/sec. [A.Stettbacher, Spreng-und Schiesstoffe, Zürich (1948), p 107].

Funkenchronograph (Spark Chronograph). See Chronographs in the general section.

Funkenzünder [Spark Igniter or Primer (Electric) Devices], such as Bornhardt's are described in Beyling-Drekopf (1936), p 216.

Furfural Alcohol was used to initiate the combustion of gasoline at the moment of its coming in contact with mixed nitric-sulfuric acid; called SV-Stoff in Germany (CIOS 30-115, p 11).

Fuse (Zündschnur oder Zeitzünder). See general section and also Beyling-Drekopf, Sprengstoffe und Zündmittel, Berlin (1936), pp 161-66.

Fuse (Obsolete). Daniel, Dictionnaire des Matières Explosives (1902) described a fuse called "mèche allemande" (German fuse). It consisted of a strip of paper impregnated with sulfur and saltpeter, then dried and inserted in a paper tube containing a small amount of fine grain black powder. The ensemble was placed in a bore-hole on top of a cartridge of a blasting explosive. After igniting the strip of paper, the operator took cover.

Fuse, Safety (Sicherheitszündschnur). See under Fuses in the general section.

Fusehead is the combination of bridge wire, igniter bead (drop) and lead-in wires. It is a component of electric primers and detonators [BIOS Final Rept 833, Item 2, p A3/27]

Note: In CIOS Report 24-3, p 7 the same combination is called "Electric Match Head".

Fusehead "A6". Low-tension fusehead introduced during WWII as a substitute for fusehead "G3" after it became difficult to obtain the cerium-magnesium metals necessary for the preparation of Mischmetall (mixed metal) one of the essential ingredients of "G3".

The "A6" were prepd at Troisdorf Fabrik by dipping the tip of a bridge wire (called also fuse) successively into the following liquid compositions:

a) 1st dip which consisted of dry Pb picrate 90g and silicon (20 to 40 microns) 10g, all suspended in about 75 ml of a 2% solution of NC in amyl or butyl acetate. The coating was then dried

b) 2nd dip which consisted of dry Pb-picrate 50g, Pb chromate 35g and silica (20 to 40 microns) 15g, all suspended in about 75 ml of 3% solution of NC in amyl or butyl acetate. The coating was again dried

c) 3rd dip which was a lacquer consisting of a 15% solution of NC in 75/25 butyl acetate/ethanol, to which was added (20% dry weight of NC) Sipalin AOM, which is the methylcyclohexyl ester of adipic acid

d) 4th dip was the same as the 3rd, but it contained 0.8g of Sudan Brown per each 10 l of lacquer.

Note: Soldering of fuse wires to lead-in wires, preparation of the dry ingredients for fuseheads dips, preparation of NC lacquers and the process of dipping the fuseheads combs are described under Fusehead Manufacture.

Reference: BIOS Final Report 833, Item 2 (1946), p A3/35.

Fusehead Comb. A new type of fusehead suitable for mechanical production was developed during WWII at Troisdorf. It consisted of a strip of sheet steel from which the outline of a comb was stamped. The two legs of each fusehead were then bonded together with "Mipolam", the tips of the teeth suitably bent and the bridge wire soldered into position. After dipping the bridge wires into fusehead compositions, the back of the comb was sheared off [BIOS Final Report No 833, Item 2, London, (1946), p A3/36].

Fusehead "G3". Low tension fuseheads used in gasless delay detonators were prepared at Troisdorf Fabrik by dipping the tip of the "bridge wire" (fuse) successively in the following liquid compositions:

a) 1st dip which consisted of 77g dry lead picrate 18.5g cerium-magnesium mixture (Mischmetall) and 4.5g alderwood charcoal, all suspended in about 75 ml of a 2% soln of NC in amyl, or butyl acetate. The coating was dried

b) 2nd dip, which contained 43.7g lead picrate, 25g, aluminum (prepd by crushing Al foil to a particle size of 10 to 20 microns), 25g cerium-magnesium and 6.25g alderwood, all suspended in 75ml of a 3% soln of NC in amyl, or butyl acetate

c) 3rd dip which was a lacquer consisting of a 15% solution of NC in butyl acetate/ethanol-75/25, to which was added (20% of the dry weight of NC) Sipalin AOM, which is the methylcyclohexyl ester of adipic acid. This lacquer was fairly impermeable to moisture and cracked less readily than straight NC lacquers.

d) 4th dip which consisted of the 3rd dip to which was added 0.8g of Sudan Brown dye for each 10 l of lacquer).

Fuseheads made with G3 composition developed heat amounting to 580 cal/g, the pressure developed by 1g was 880 atm and the volume of gases 190 cm^3 per g at NTP. The disadvantage of G3 was its hygroscopicity, which made it unstable in storage.

References:

1) BIOS Final Report 833, Item 2 (1946), p A3/34

2) PB Rept 95,613 (1947) Section D.

Fusehead Manufacture. The bridge wire ("fuse") made from an alloy 80/20-Ni/Cr, (or 60/15/17/7/1-Ni/Cr/Fe/Mo/Mn) was soldered to two lead-in wires (made of soft iron 0.60 mm in diameter) by means of a 60/40-Sn/Pb solder and Zn chloride flux. The wires were coated with a 0.25 mm layer of Mipolam. Without cleaning the flux from solder, the tip of the fusehead (bridge wire) was dipped into an igniter composition, such as fusehead composition A6, fusehead composition G3, Spalt, or Marapille. Each fusehead required four dips which were conducted as follows:

A number of fusehead assemblies were inserted in a special frame placed over a pan containing an appropriate dip mixture, and the frame lowered until the tips of the fuseheads were immersed in the liquid (dip). Then the frame was removed from the dip, turned upside down and slowly moved (with the fuseheads uppermost) through a semi-circle for 15-30 seconds. After this, the frame was hung by the handles from cleats affixed to endless chains leading to drying tunnels. The tunnels were about 50 feet long and were heated by steam from below the bottom plates. The 2nd, 3rd and 4th dips were conducted in the same manner as the 1st one. After being dipped and dried, the fuseheads were graded for resistance, using a special automatic machine. For low tension fuseheads the requirement was 1.0 to 2.4 ohms and they were graded in ten steps; 1.0 to 1.2, 1.2 to 1.4..........2.2 to 2.4. For high tension fuseheads (such as "Spalt"), the usual resistance range was 3,000 to 15,000 ohms but the upper limit was not specified because it was found that fuseheads of 100,000 ohms, or even more, functioned satisfactorily.

Notes:

a) Preparation of dry ingredients for fusehead dips. The dry ingredients for fusehead dips, with the exception of Mischmetall, were usually mixed behind a barricade in a graphited papier maché drum, 6" diameter and 10" long, provided with an aluminum lid. The drum was rotated at 14 rpm. Six No 6 soft rubber stoppers were placed inside the drum to aid mixing.

The Mischmetall was considered to be too inflammable to mix in the dry state with the other ingredients and was always added separately after the other ingredients had been added to the NC varnishes. (The Mischmetall was previously pulverized by grinding it under xylol in a small ball mill. Then the xylol was decanted and the slurry was transferred to filter paper on a funnel, where it was washed with benzene, spread on trays and dried;

b) Preparation of NC varnishes for fuseheads. Before 1943, amyl acetate was used as the solvent but when it became unavailable, butyl acetate had to be used although the workers objected to it because it affected their breathing even more than amyl acetate

Two grades of NC were used for the preparation of fuseheads E 620 and E 1160 (N content was not given) and both of them were received at the fusehead factory wet with about 30% ethanol

The preparation of the varnish consisted in a thorough blending of the alcoholic NC with the desired amount of of butyl acetate in an iron drum provided with a wooden paddle stirrer

c) Mixing of the dry ingredients with NC varnish. A slightly smaller amount of NC varnish than required by the formulation was measured into an 8" diameter "Pollopas" plastic bowl and the dry ingredients were slowly added while continually stirring with a wooden spatula. Any Mischmetall required was then stirred together with the remainder of the NC varnish. The dip was thoroughly mixed by hand, using a wooden spatula, for at least one-half hour. The viscosity of the dip was then measured and if it was too high, it was reduced by adding small quantities of butyl acetate.

References:

1) R.Ashcroft et al, Investigation of German Commercial Explosives Industry, BIOS Final Report No 833, Item No 2, London, H M Stationery Office (1946), Appendix A3, p 27

2) Anon, Manufacture of German Detonators and Detonating Compositions, PB Rept No 95,613 (1947), Section D.

FUZE (Zünder) German fuzes may be subdivided into Bomb Fuzes and Projectile Fuzes. The first group was used in aerial bombs, some booby traps and in some pyrotechnic devices and the second group in shells and rockets.

A. **Bomb Fuze** (Bombenzünder). The Germans employed both mechanical and electrical-bomb fuzes. The mechanical types were used in smaller bombs (such as 2 kg, 12 kg and 50 kg) and in some booby traps, whereas the electrical fuzes (developed and manufactured by the Rheinmetall-Borsig Co) were used in all kinds of HE bombs and in flares. Among the electrical fuzes was the "proximity fuze", type 6 used in incendiary bombs C 250 Flam and C 500 Flam.

According to Ref 1 there were ten basic types of bomb fuzes:

1 Mechanical impact and flare fuzes; used in 2 kg Butterfly bombs and 2 & 4 candle flares

2 No record

3 Mechanical impact fuze; used in 12 kg A/P bomb

4 Mechanical impact fuze; used in SC 2500 bomb

5 Impact fuze: instantaneous or short delay; (land targets); used in HE (SC or SD) bombs

6 Proximity fuze; used in C 250 and C 500 Flam bombs

7 Long delay time bomb fuze; used in HE bombs

8 Impact fuze (sea targets) with slight delay to effect detonation at some depth below the surface used in HE (SC or SD) bombs

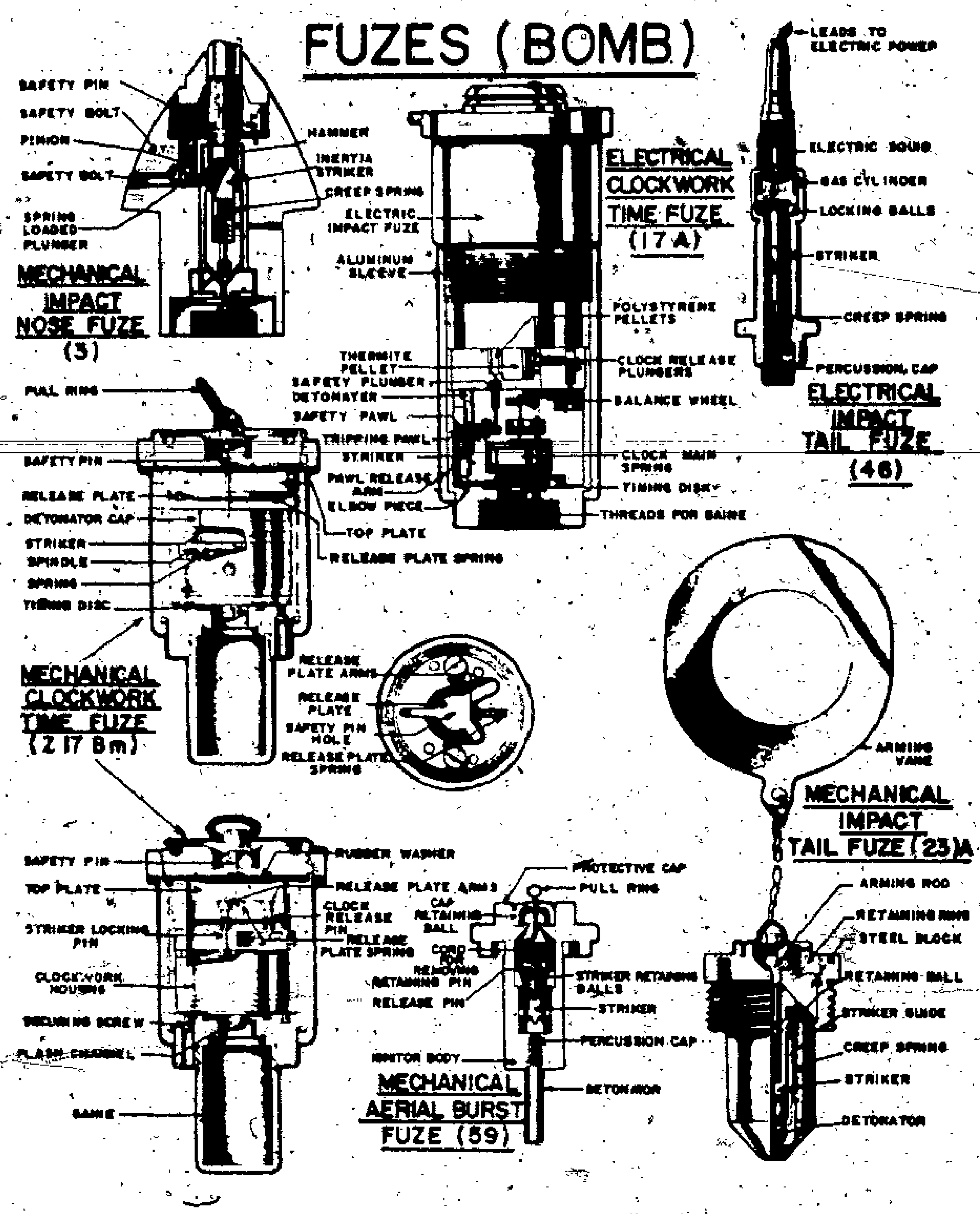
9 Aerial burst (short time) fuze, used in parachute flares and photoflash bombs

10 Protective fuze; used in booby traps and SC 250 & 500 kg bombs.

Each of the above basic types existed in one or several variations. The following chart, based on the information obtained from Refs 2 and 4, lists these variations according to their numerical designations:

1) Mech Imp Nose Fz (3) AZC 10 (Hot)*, Type 3 used in SC 12 kg A/P bomb (Ref 4, p 134)

2) (5) Elec Fuze was forerunner of Type 5 fuzes, but is now obsolete. The A variety was manufd in Spain (Ref 1,



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3) Elec Short Time Aerial Burst Fz ElZtZ (9) or (9)* used in parachute flares and photoflash and gas bombs (Ref 4, p 167)
4) Elec Imp Fz ElAZ (15), or ElAZ C 50 (15) (obsolete) was used in SC 50 to 2500 kg, SD 50 to 1400 kg and SBe 50 kg bombs (Ref 2, file 2321.5 and Ref 4, p 139)
5) Elec Mech Long Delay Time Fz ElAZ (17), Type 7 used in SC 250 and 500 kg bombs having two pockets (Ref 4, p 152)
6) Elec Mech Time Fz ElAZ (17)A, ElAZ (17)A*, ElAZ (17)B* used in the same bombs as ElAZ (17) (Ref 4, p 154)
7) Mech Time Fz Z 17Bm used in SC 500 & 1000 kg, PC 1000 kg and BSB 1000 kg bombs and Hs 293 flying bomb (Ref 4, 155)
8) Mech Imp Tail Fz (23)A used in Brand 10 kg, NB 2 kg and SG 3 kg bombs, as well as in single unit parachute flares (Ref 4, p 134)
9) Mech Imp and Antibreak-up Fz (24) and (24)A used in the forward pocket of SC 2500 bomb (Ref 4, pp 135-8) (See a brief description under Antibreak-up Fuzes)
10) Elec Imp Fz ElAZ (25), (25) A, (25) A* & (25) A** used in HE bombs (Ref 4, p 140)
11) Elec Imp Fz ElAZ (25) B, 25 B, (25) C & (25) D used in SC 50 to 500 kg and some Inc bombs (Ref 4, pp 141-2)
12) Elec Proximity or Imp Fz, Special ElAZ (26) used in Inc bomb KC 250 "Flam" (Ref 4, p 144)
13) Elec Imp Fz ElAZ (28)A used in HE bombs SC 50 to 2500 kg and Inc bomb C 250 (Ref 4, p 163)
14) Elec Imp Fz ElAZ 28 (*) or ElAZ C 50 28 (*) used in HE bombs (Ref 4, p 162)
15) Elec Imp Fz ElAZ (28)B used in SC bombs against sea targets (Ref 4, p 163)
16) Elec Imp Fz ElAZ (28) B^2, (28) B^8 & (28) $B^{0.7}$ used in HE bombs (Ref 4, pp 163-4)
17) Mech Aerial Burst Fz (29) used in LC 10f parachute flare (Ref 4, p 168)
18) Elec Imp Fz ElAZ (35) used in HE and AP bombs (Ref 4, p 142)
19) Elec Imp Fz ElAZ (38), (38umg) & (38u) used in HE bombs (Ref 4, pp 165-6)
20) Elec Imp Fz ElAZ (38 al) used in SC 250 kg bombs when employed as depth charges against U-boats (Ref 4, p 166)
21) Elec Imp Fz ElAZ (38)B & (38)C used in FX 1400 and HE bombs (Ref 4, pp 166-7)
22) Mech Antiwithdrawal Device ZusZ 40, Types I, II & III used in SC 250 & 500 kg bombs under fuzes (17), (17)A or (17)B (Ref 4, pp 177-81)(See a brief description under Antiwithdrawal Fuzes)
23) Mech Imp Fz AZ 41 or 34-41 used in SD 2A "Butterfly" bomb (Ref 4, p 132)
24) Mec Imp or Aerial Burst Fz "AZ (41) A cor" was used in SD 2 B "Butterfly" bomb (Ref 4, p 132)
25) Elec Imp Fz ElAZ (45); uses are unknown (Ref 4, p 142)
26) Elec Imp Fz ElAZ (45) A used in SC 50 bombs (Ref 4, p 142)
27) Electrically Armed Mech Imp Tail Fz AZ (46) used in KC 50 gas bombs (Ref 4, p 145)
28) Rocket Bomb Fz Assemblies (49)A & (49) B, Type 9 used in PC 500RS, 1000RS bombs and 1800 kg "Erdstuka" (Ref 2, file 2324.92 & 4, p 169)
29) Rocket Bomb Fz Assembly (49)C used in PC 1800RS (Ref 4, p 170)
30) Elec Antidisturbance Fz 50 and (50) used in SC 250 and 500 kg bombs in conjunction with fuzes (17), (17) A or (17) B (Ref 4, pp 181-3)
31) Elec Antidisturbance Fz 50b or "Y" (See under Antidisturbance Fuzes) used in HE bombs alone, or in conjunction with other Rheinmetall fuzes (Ref 4, p 184)
32) Elec Imp Fz ElAZ C50 (5) (obsolete) & C/50 (15) used in HE bombs (Ref 4, p 139)
33) Elec Imp Fz ElAZ (55)(tp), (55)A/M & (55)A* used in SD & SB and other bombs requiring instantaneous action (Ref 4, pp 143-4)
34) Elec Chemical Time Fz ElAZ (57) used in "Stabo" bombs (Ref 4, p 157)
35) Mech Aerial Burst Fz (59) used in single & four candle parachute flares and BIC 50 photoflash bombs (Ref 4, p 1"))
36) Elec Aerial Burst Fz 59A & (59)A used in A/P and Inc containers (Ref 4, p 172)
37) Elec Aerial Burst Fz (59) B used in some HE bombs and parachute flares (Ref 4, p 172)
38) Mech Aerial Burst Fz Z 60 used in supply dropping containers (Ref 4, p 186)
39) Special Imp Fz Z66 used in SD 10A bomb (Ref 4, p 146)
40) Mech Time Fz AZ (67) Zeit used in SD 2B "Butterfly" bomb. It was located centrally in the upper longitudinal surface of the bomb (Ref 4, p 159)
41) Mech Time Fz 67/V used in Mk Ab 70 container to ignite 2 of the 3 candle units housed in the container (Ref 4, p 160)
42) Elec Aerial Burst Fz, Pyrotechnic Delay 69C II, 69D & 69E (Ref 4, p 173) used in AB 36, 250, 500 & 1000 and BDC 10 containers
43) Chem Mech Long Delay and Antidisturbance Fz (70)A used in SD 2B bomb (Ref 4, p 187)
44) Mech Antidisturbance Fz (70)B & (70) B/1 used in SD 2B bomb (Ref 4, p 187)
45) Modified Mech Antidisturbance Fz (70) B umg used in aircraft towed paravane bomb (Ref 4, p 188)
46) Elec Aerial Burst Fz, Pyrotechnic Delay ElZtZ 79, (79) & (79)A used in parachute flares, SC 250 & 500 bombs, A/P & Inc containers and photoflash bombs (Ref 4, p 174)
47) Mech Imp "All-Ways" Action Fz VZ (80) used in Hs 293 flying bomb (Ref 4, p 189)
48) Ditto VZ (80) A used in V-1 flying bomb (Ref 4, p 190)
49) Mech Aerial Burst Fz Z (89) used in photoflash bomb, parachute flares and some containers (Ref 4, p 175)
50) Ditto Z (89)B, (89)C & (89)D used in some containers (Ref 4, p 177)
51) Elec Imp Fz ElAZ (106)* used in Flying Bomb "Peenemünde 16" (Ref 4, p 149)
52) "Dust Fuze" used in SD 10 bombs (Ref 4, p 191) (See description under D).

Following are abbreviations and designations used for bomb fuzes:

AZ	Aufschlagzünder	Impact fuze
ElZtZ	Elektrischer Zeitzünder	Electrical time fuze
ElZ	Elektrischer Zünder	Electrical (fuze)
LZt	Langzeit	Long time (delay)
VZ	Vorzugszünder	Safety fuzing
Z	Zünder	Fuze
ZtZ	Zeitzünder	Time fuze
Zu	Zusatz	Addition
ZZ St	Zünderzwischenstück	Fuze extension cap

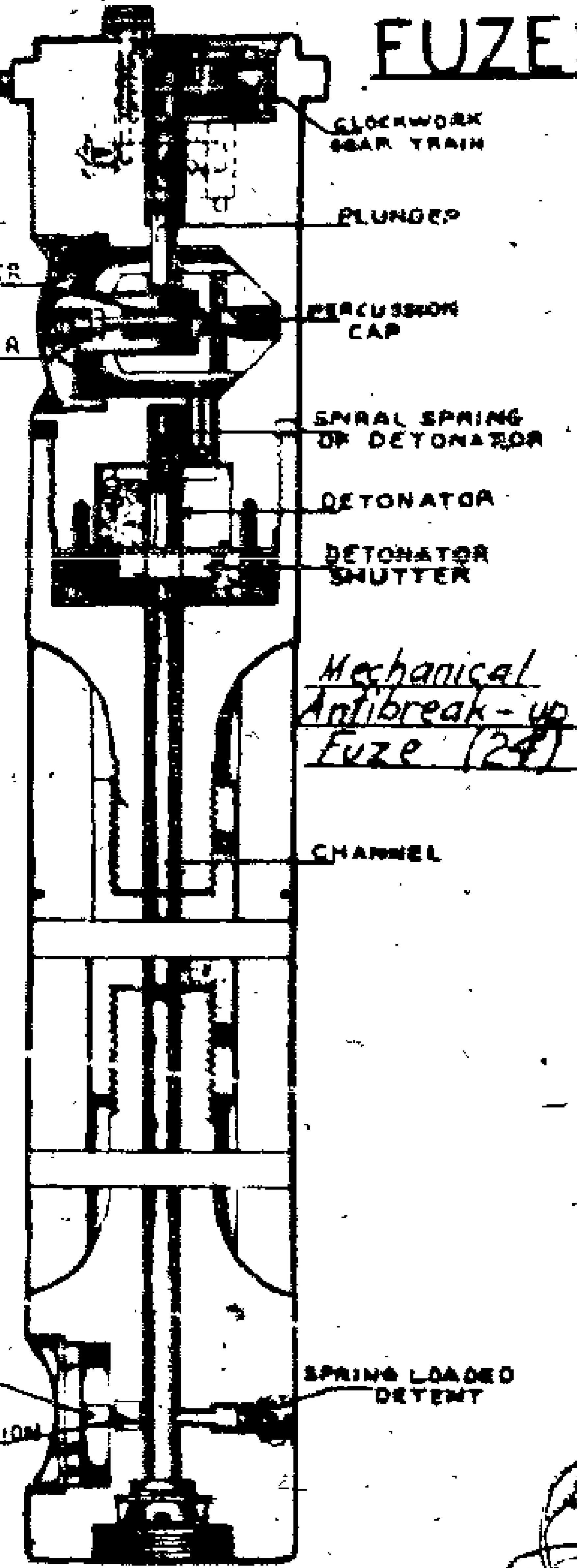
Other German abbreviations are given at the end of this German section, following the Vocabulary

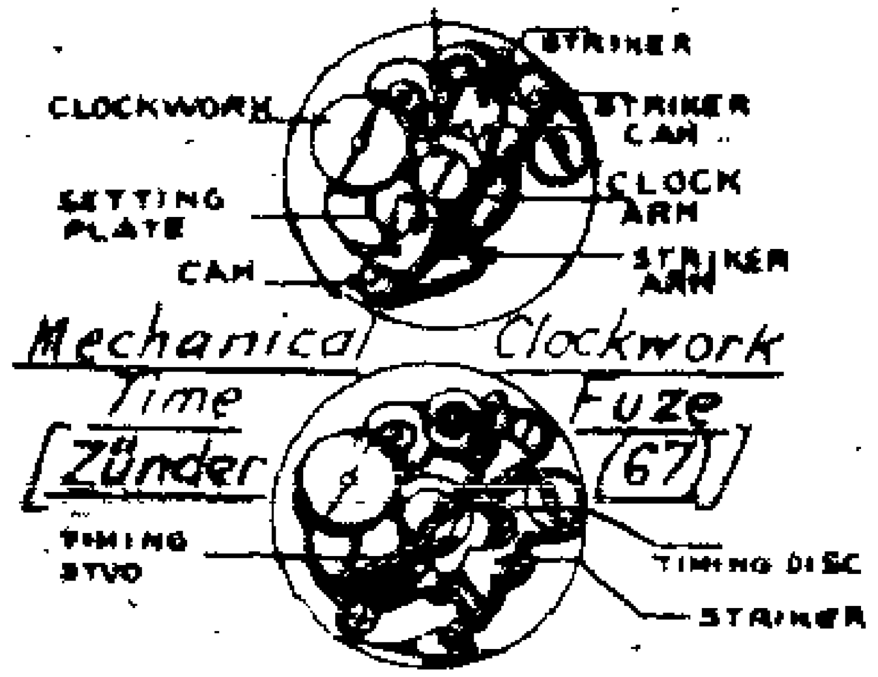
Several of the German bomb fuzes were examined at Picatinny Arsenal as can be seen from the following reports:
a) A.B.Schilling, Pic Arsn Tech Rept 1572 (1945) (Chemical Long Delay Bomb Fuze, ElAZ)
b) A.B.Schilling, ibid, 1574 (1945) (Mechanical Time Long Delay Bomb Fuze, L Zt Z)
c) A.B.Schilling, ibid, 1581 (1945) (Instantaneous and Long Delay, Bomb Fuze, El AZ 55A)

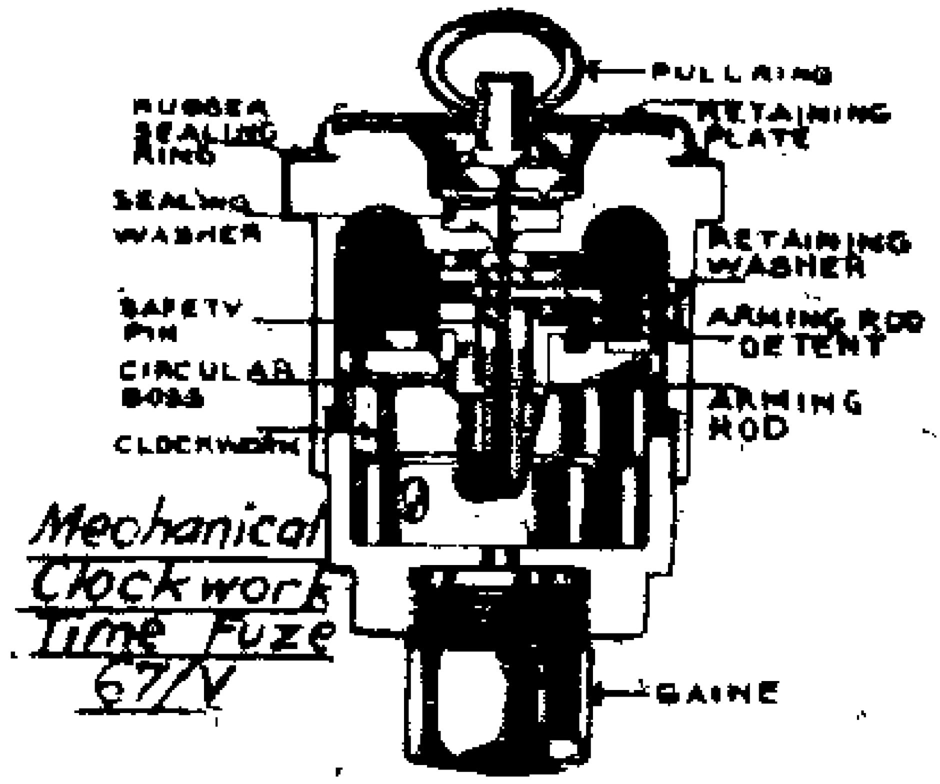
(See also Aerial Burst, Antidisturbance and Electric Fuzes)

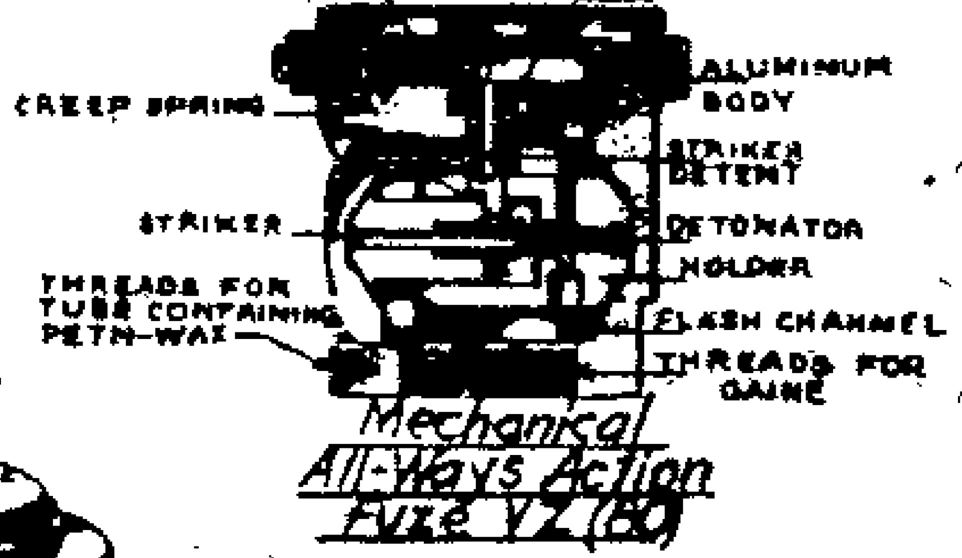
B. **Projectile Fuze** (Geschosszünder) existed even in a greater variety than bomb fuzes. The former may be subdivided into Point Detonating (PDFz) and Base Detonating (BDF) types. A brief description of typical

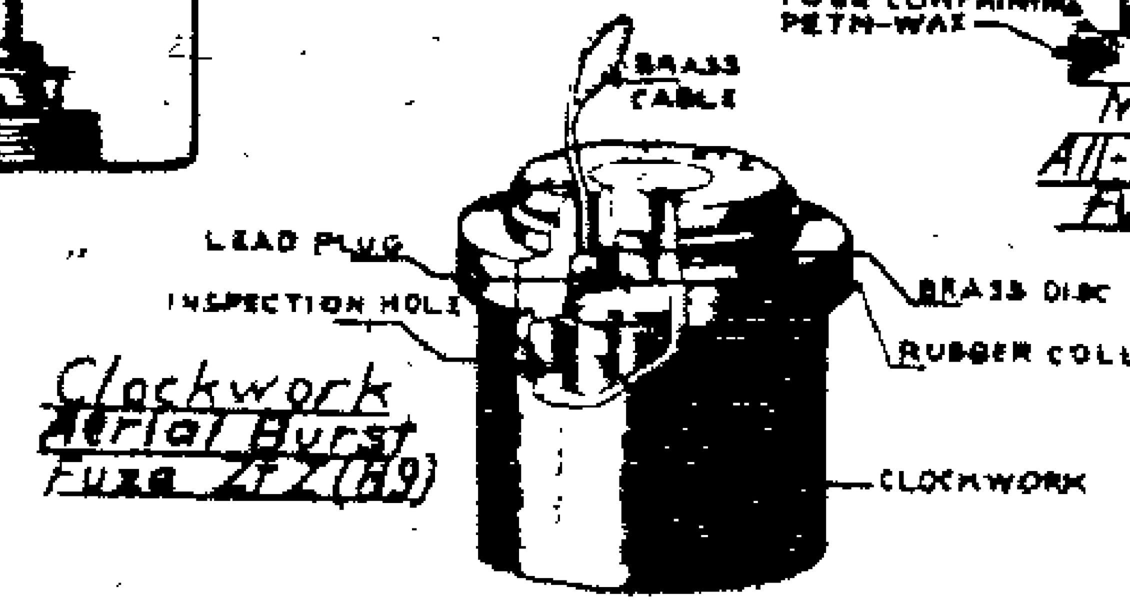
FUZES (BOMB)



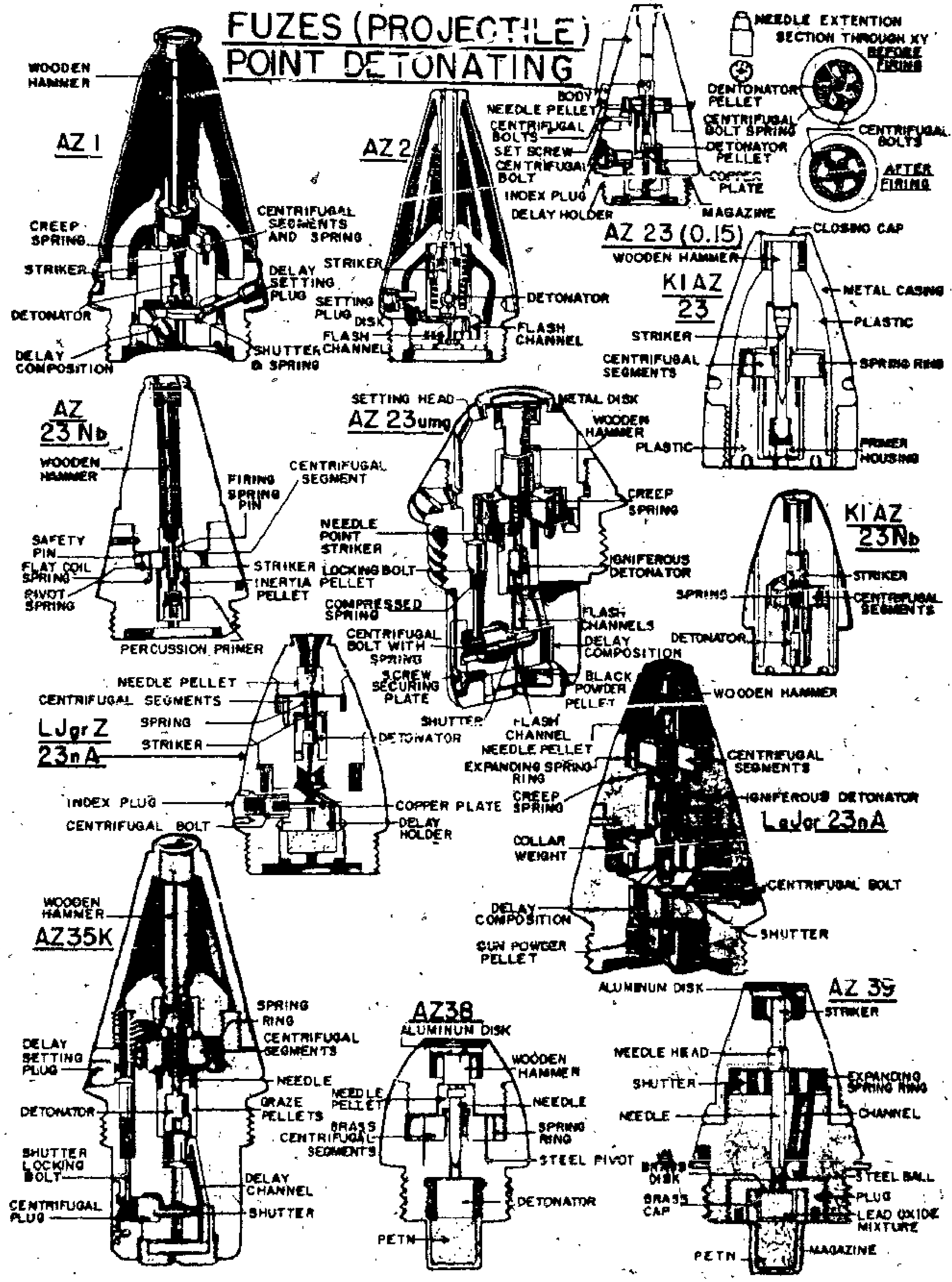








FUZES (PROJECTILE) POINT DETONATING



German projectile fuzes is given by Engleaburg (Ref 2)
The following types are listed and briefly described in Refs 3 and 5:

I. Point Detonating Fuze

1. Imp Fz AZ 1 used in 75 mm and larger caliber shells (Ref 5, p 586)

2. Imp Fz AZ 2 uses not indicated (Ref 5, p 588)

3. Perc Fz AZ 23 Series were the most important and used throughout for German Artillery Ammunition, mostly for 75 mm and larger calibers. All the different fuzes bearing the number 23 were similar in functioning and major differences among them were in the delay. The 23 type fuzes existed in the following variations:

a) Perc Fz (with delay 0.15 and 0.25 sec) aluminum body* AZ 23V(0.15) and 23V(0.25) used in shells for 75 mm Gun and 105 mm Howitzer (Ref 3, p 339 & 5, p 571)
b) Perc Fz AZ 23Geb used in the 75 mm Mountain Gun (Ref 5, p 576)
c) Perc Fz plastic body AZ 23V(0.15)(Pr) and AZ 23V(0.25)(Pr); uses not indicated (Ref 3, p 353)
d) Perc Fz plastic body AZ 23Nb(Pr) used in 150 mm. Smoke shells (Ref 5, 607)
e) Perc Fz zinc body AZ 23V(0.25)(Zn) and AZ 23V(0.25)(Zn); uses not indicated (Ref 5, p 573)
f) Modified Perc Fz AZ 23umg used in 75 mm and 105 mm HE shells (Ref 5, p 575)
g) Perc Fz AZ 23/28 used in 88 mm HE AA shells (Ref 3, p 349)
h) Perc Fz (delay 0.15 sec) AZ 23/42V(0.15); uses not indicated (Ref 5, p 573)
i) Perc Fz (modified) IJgrZ 23nA used in 75 mm Light Infantry guns Another model of IJgrZ 23nA was used in 210 mm Rocket 42 (21 cm Wgr 42 Spr) (Ref 5, p 583)
j) Perc Fz and Perc Fz (delay 0.4 sec) sJgrZ 23 and 23V(0.4); uses not indicated (Ref 3, p 346 & 5, p 579)
k) Perc Fz sJgrZ 23Nb (sIgrZ 23Nb) used in Smoke shells (Ref 5, p 575)

Note. Other less important, versions of fuze 23 included: AZ 23 (obsolete), AZ 23V(0.8), AZ 23(0.2) and AZ 23 (0.2)(umg) (Ref 5, pp 573-4)

4) Small Perc Fz klAZ 23 Series existed in the following variations:

a) Perc Fz (small) klAZ 23 used in 75 mm HE and 75 mm & 105 mm Smoke shells (Ref 5, p 576)
b) Perc Fz klAZ 23Nb used in Smoke shells (Ref 5, p 578)
c) Perc Fz with delay 0.2 sec, modified klAZ 23V (0.2)(umg) used in 75 mm A/T Guns 40, 42, 76.2 mm Russian A/T Gun 36 and Field Gun 39 (Ref 5, p 574)

Note: Other, less important, versions of small fuze 23 included klAZ 23V(0.2), klAZ 23/1, klAZ 23V(0.2)(Pr) and klAZ 23Nb(Pr) (Ref 5, pp 574 & 578)

5) Igniferous DA and Graze Type Fz (with a combined graze and DA mechanism) AZ 35K used in 170 mm HE Shell (Ref 5, p 580)

6) Mech Imp Fz AZ 38 used in HoC projectiles (Refs 3, p 333 & 5, p 568)

7) Detonating Imp Type Fz (with DA mechanism) AZ 39 used in 50 mm HE shell (Refs 3, p 337 & 5, p 569)

8) Perc Fz klAZ 40Nb & 40Nb(Pr) used in Smoke projectiles (Ref 5, p 579)

9) Perc Fz AZ 47 & AZ 48, similar in construction to AZ 19, were used in 20 mm Ammo (Ref 5, p 571)

10) Perc Fz AZ 49 used in 20 mm Shell (Ref 5, p 571)

11) DA Imp Fz AZ 150 & 150RhS used in 20 mm Shell (Ref 2, p 315 & 5, p 564)

12) Imp Fz AZ 1502F used in 20 mm Shell (Refs 3, p 303 & 5, p 547)

13) Imp Fz AZ 1503 used in 20 mm Shell (Refs 3, p 309 & 5, p 547)

14) Imp Fz AZ 1504 used in 20 mm Shell (Refs 3, p 309 & 5, p 547)

15) Imp Fz AZ 1531 used in 20 mm Shell (Refs 2, p 315 3, p 307 & 5, p 549)

16) Imp Fz AZ 1532 used in 13 mm Projectile (Ref 5, p 550)

17) Imp Fz AZ 1551 used in 15 mm Projectile (Refs 2, p 316 & 5, p 550)

18) Imp Fz AZ 1552 used in 15 mm Projectile (Ref 5, p 556)

19) DA and Graze Fz AZ 2492; uses not indicated (Ref 5, p 556)

20) Imp DA Fz AZ 5045 used in 20 mm Shell (Ref 5, p 552)

21) Mech Imp Fz AZ 5072 used in 28/20 mm and 42/28 mm HE shells for Tapered Bore guns (Refs 3, p 313 & 5, p 553)

22) Imp Fz AZ 5075, AZ 5075 mK & DAAZ 5075 used in 37 mm Rodded A/T Bomb (3.7 cm Pak Stielgranate) (Refs 3, p 319 & 5, pp 554-5)

23) Imp Fz AZ 5095 used in 88 mm A/T HoC Rocket (Ref 5, p 555)

24) Imp Fz AZ f Hbgr used in 150 mm Shell with BC (Ref 5, p 586)

25) Mech Time and Imp Fz Dopp Z 28K used in 210 & 280 mm projectiles (21 cm KGr 38 & 28 cm Gr 39) (Ref 5, p 605)

26) Mech, Time and/or Imp Fzs DoppZ S/60 Fi used in 88 mm and 105 mm HE AA shells (Refs 3, p 383 & 5, p 605)

27) Ditto DoppZ S/60 s; uses not indicated (Ref 2, p 318)

28) Mech Time and Graze Action Fz DoppZ S/90/45 used in 170 mm Gun in Mortar Mounting (17 cm K i MrsLaf) (Ref 5, p 601)

29) Combination Fz DoppZ S/160Geb used in shells for Mountain guns (Ref 5, p 596)

30) Supersensitive Imp Fz EKZ C/28 used in shells for Naval guns (Ref 5, p 565)

31) Elec Time Fz ElZtZ S/30; uses not indicated (Ref 5, p 605)

32) Imp Instantaneous and Delay Fz under BC HbgrZ 35D used in 210 mm Rocket (21 cm Wgr 42 Spr) (Ref 5, p 585)

33) Ditto HbgrZ 35K used in 170 mm HE Shell (Ref 3, p 391)

34) Imp Fz (Russian Design) KTM-1 used in 76.2 mm HE Shell (Ref 3, p 377)

35) DA Detonating Type Fz KZ f 4.7 cm Pak Sprgr used in 47 mm HE Shell (Ref 5, p 566)

36) Mech Imp Fz (with a self-destroying arrangement) KZ ZerlPr used in 37 mm HE AA Shell (Ref 5, p 557)

37) DA Mech Imp Fz (with a safety device which is released by the disintegration of a pellet of gunpowder) KZ ZerlPr used in 37 mm HE A/T Shell (Ref 5, p 558)

38) Mech Imp Fz KZ 38 used in 40 mm HE Shell for Bofors Gun (Refs 3, p 325 & 5, p 561)

39) DA Imp Fz KZ 38; uses not indicated (Ref 5, p 561)

40) Mech Imp Fz (self-destroying) KZ 40ZerlPr used in 37 mm HE AA Shell (Refs 3, p 315 & 5, p 557)

41) Graze and DA Fz KZ C/27(LM) used in projectiles for Naval Guns (Ref 5, p 565)

42) DA Detonating Type Fz used in 47 mm HE A/T Shell (4.7 cm Pak Spgr) (Ref 3, p 327 & 5, p 566)

43) Imp Fz (Czech Design) M 35ENZ 3/40 used in 47 mm German Ammo (Refs 3, p 331 & 5, p 568)

44) Perc Fz (Skoda Design) used in 75 mm and 83.5 mm projectiles (Ref 5, p 589)

45) Combination Time and Imp Fz VZ 25; uses not indicated (Ref 2, p 318)

46) Perc Fz WgrZ 36 used in 150 mm Rodded Bomb & 200 mm Spigot Mortar Bomb (Ref 3, p 389)

47) Mech Imp Fz WgrZ 38 used in 50 mm HE Mortar Bomb (Refs 3, p 335 & 5, p 592)

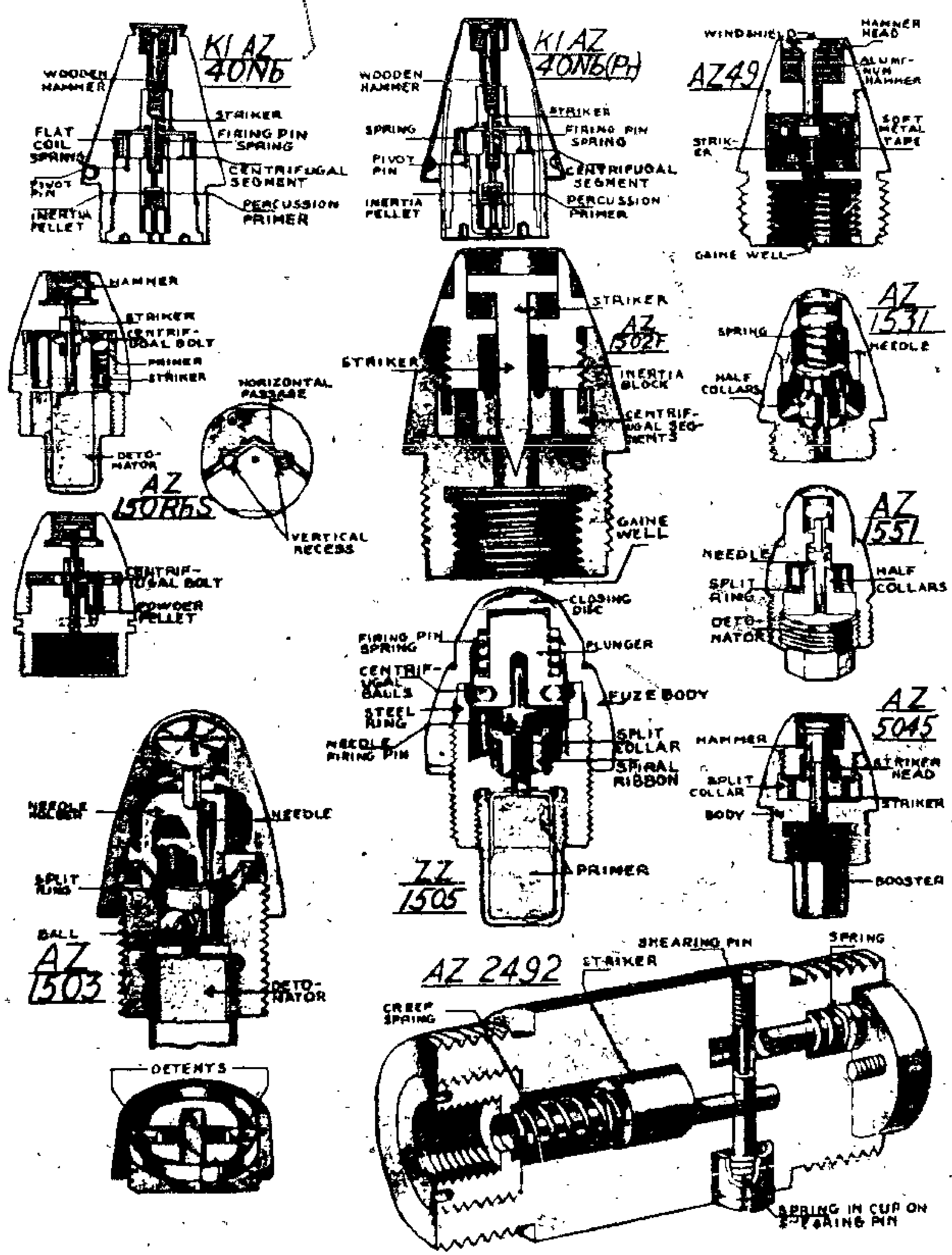
48) Imp Fz WgrZ 50 used in 280 mm, 300 mm & 320 mm Rockets (Refs 3, p 397 & 5, p 593)

49) Imp Fz (plastic body) WgrZtZ ACB used in 80 mm Smoke Mortar Shell (Ref 3, p 381 & 5, p 591)

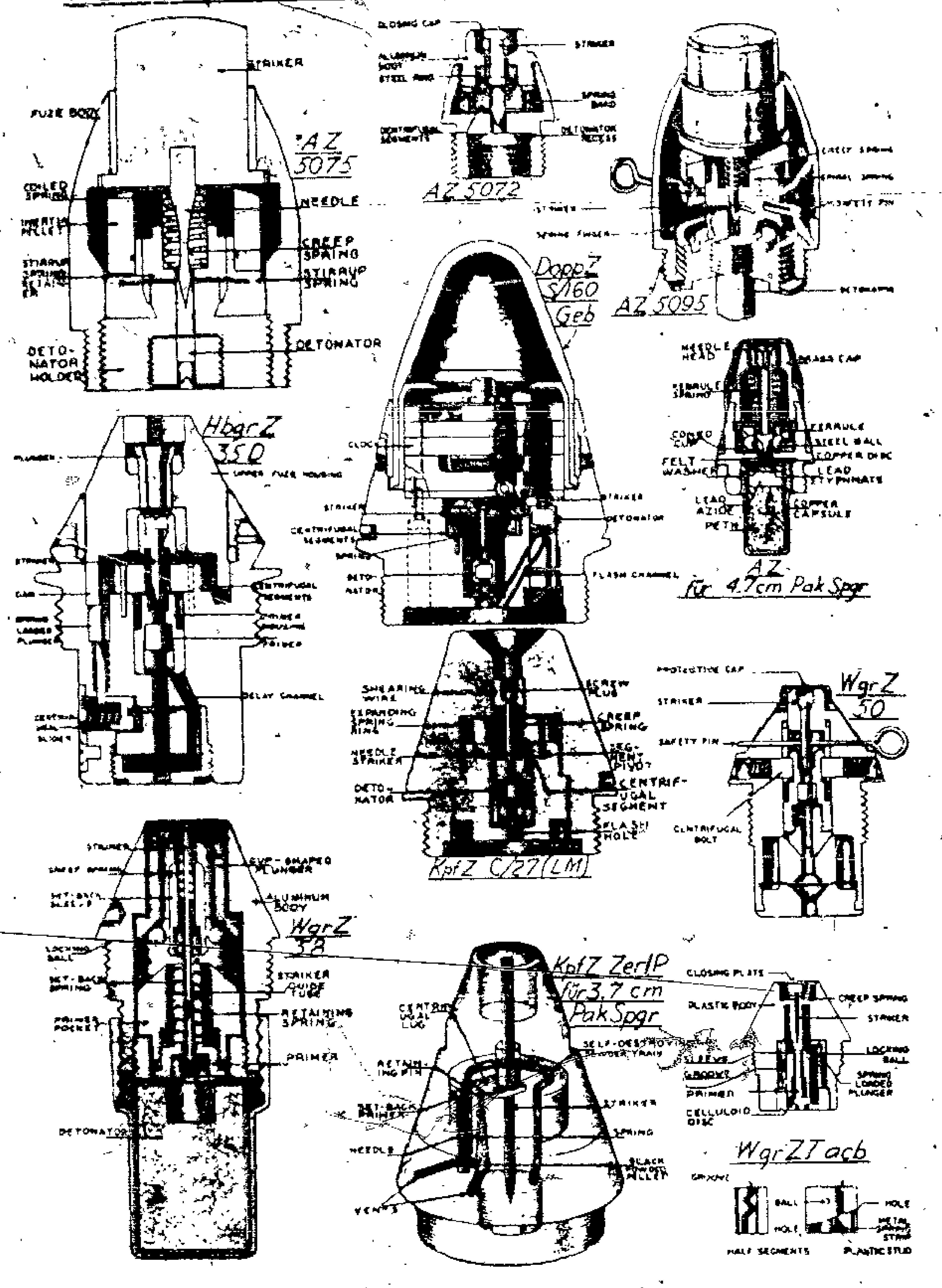
50) Imp Fz Z 45 used in 20 mm Shell (Ref 3, p 304 & 5, p 551)

51) Mech Time Fz ZtZ S/30 & ZtZ S/30Fgl used in 88 mm & 105 mm HE AA shells (Refs 3, p 359 & 365 and 5, p 594 & 597)

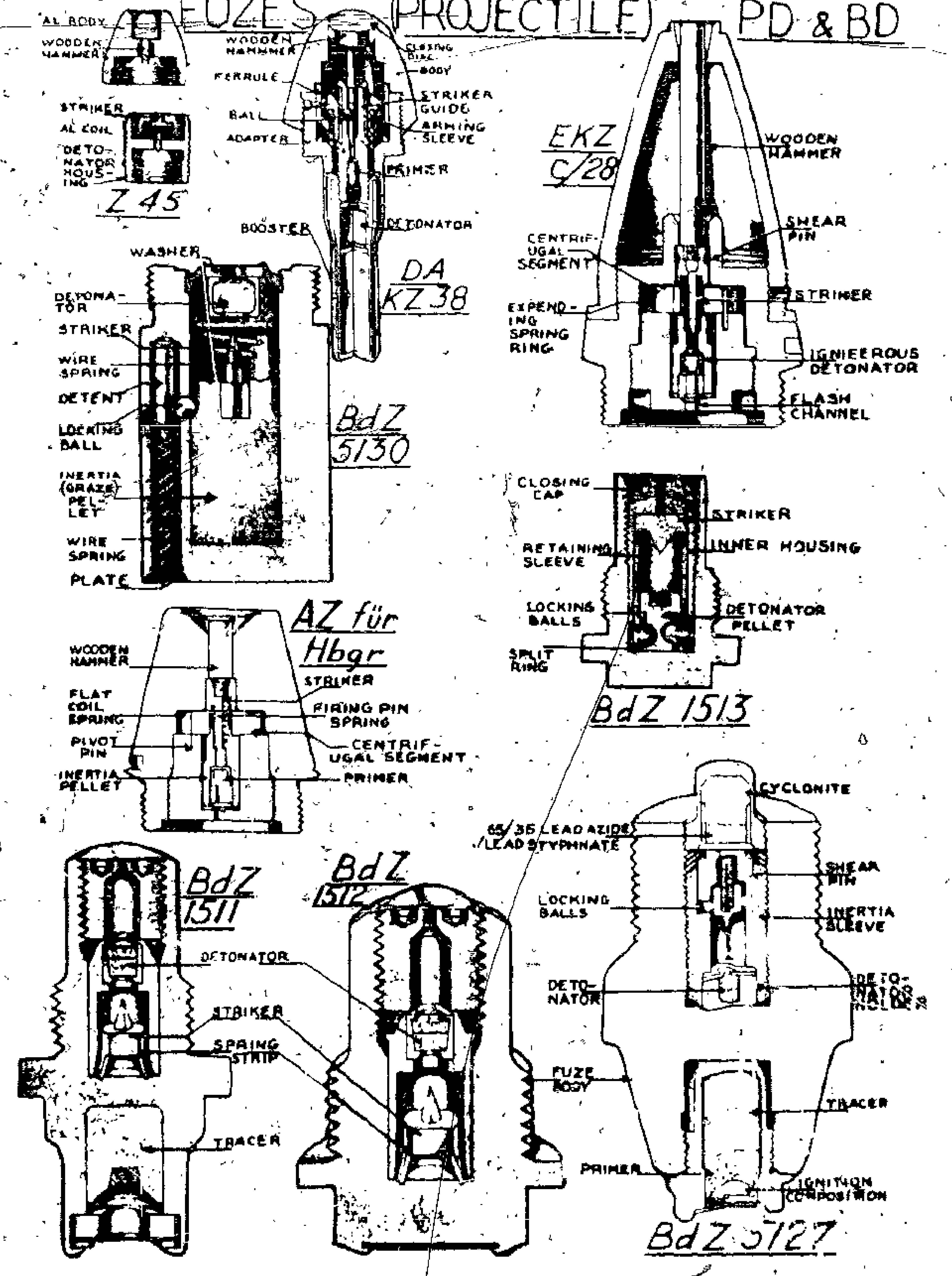
FUZES (PROJECTILE) POINT DETONATING



FUZES (PROJECTILE) POINT DETONATING



FUZES (PROJECTILE) PD & BD



32) Self-Destroying Fz ZZ 1505 used in 20 mm Mauser Gun (Refs 3, p 311 & 5, p 548)

II. Base Detonating Fuzes (BDFz)

1) Imp Fz BdZ 1511 used in 20 mm Shell (Refs 3, p 399 & 5, p 608)
2) Imp Fz BdZ 1512 used in 20 mm Shell (Refs 3, p 399 & 5, p 608)
3) Imp Fz BdZ 1513 used in 20 mm Shell (Ref 5, p 609)
4) Imp Fz BdZ 5127 used in 88 mm APC BC Shell (Refs 2, p 319 & 5, p 609)
5) Graze Action Fz BdZ 5130 used in 37 mm Rodded Bomb (3,7 cm Stielgranate 41) (Refs 3, p 401 & 5, 611)
6) Imp Delay Fz BdZ C/38 used in heavy Naval guns (Ref 5, p 612)
7) Imp or Graze Action Fz BdZ DOV used in 150 mm Rocket (Ref 3, p 423 & 5, p 622)
8) DA Imp Fz (Small Cavity) 50 mm AP and 75 mm HE shells (Refs 3, p 411 & 5, p 617)
9) DA Imp Fz (Large Cavity) BdZ f 7.5 cm Pzgr used in 75 mm APC Shell (Refs 3, p 411 & 5, p 619)
10) Imp Fz BdZ f 7.62 cm used in 76.2 mm Russian design shells (Ref 3, p 413)
11) DA Imp Fz (Small Cavity) BdZ f 8.8 cm Pzgr used in 88 mm AP Shell (Refs 3, p 415 & 5, p 619)
12) Mech Imp Fz (Large Cavity) BdZ f 8.8 cm Pzgr used in 88 mm AP Shell (Refs 3, p 417 & 5, p 619)
13) Imp Selective Delay Fz BdZ f 15 cm Gr 19Be used in 150 mm Anticoncrete Shell (Refs 3, p 419 & 5, p 622)
14) Imp Fz BdZ M35 used in 47 mm AP Shell (Refs 3, p 407 & 5, p 615)
15) DA Impact Fz (Skoda Design): BdZ 15-28-39; uses not indicated (Ref 5, 621)
16) Elec Rimvent Fz ERZ 39 used in 150 mm & 210 mm Rockets (Refs 3, p 423 & 5, p 623)
17) Imp or Graze Fz (Polish Design), 27/34 WZ 36 used in 37 mm Polish Design Shell (Ref 5, p 614)
18) Mech Imp Fz WZ 36 used in 37 mm Polish Design Shell (Refs 3, p 405 & 5, p 615)

Following are abbreviations and designations used for projectile fuzes:

AZ	Aufschlagzünder	Impact fuze, point detonating (PD) fuze
BdZ	Bodenzünder	Base detonating (BD) fuze
DoppZ	Doppelzünder	Combination fuze (time and impact)
EKZ	Empfindlicher Kopfzünder	Sensitive type of PD fuze (under ballistic cap)
ElZ	Elektrischer Zünder	Electrical fuze
KlAZ	Kleinaufschlagzünder	Small impact fuze, small PD fuze
KpfZ	Kopfzünder	PD fuze
KZ	—	PD fuze under a ballistic cap, except in the case of KZ 38 an ordinary PD fuze
WgrZ	Wurfgranatzünder	Mortar shell fuze, infantry gun or howitzer shell fuze
ZtZ	Zeitzünder	Time fuze

Note: The letters Nb following the fuze number signify smoke shells; the letters ZerlP signify the presence of a gunpowder pellet which is destroyed on firing to release a centrifugal firing device. Fuzes with a setting device for optional delay are stamped with the letters "m", "V", "o" to indicate the position to which the slot in the setting plug must be set to cause either delay or non-delay. The "o" stamping indicates the setting position for "without delay", the "V" stamping, followed by numerals such as V(0.25), indicates delay and the figures, the period of delay. The letters "o V", stamped together, signify "ohne Verzögerung" (without delay), while "mV" signify "mit Verzögerung" (with delay).

Other German abbreviations are given at the end of this German section following the Vocabulary "American and British Abbreviations"

American and British Abbreviations: AA Antiaircraft; AC Aircraft; AP Armor-piercing; A/P Antipersonnel; A/T Antitank; B Base; BC Ballistic cap; BDFz Base detonating fuze; C Capped; D Detonating; DA Direct action; Elec Electrical; Fz Fuze; HE High explosive; HoC Hollow charge; Imp Impact; Inc Incendiary; M Mark; Mech Mechanical; Perc Percussion.

References:
1) Anon, "Enemy Bombs and Fuzes", War Dept TM E9-1983 (1942)
2) E. Englesburg, "The Components of German Artillery Ammunition", The Ordnance Sergeant, May 1944, pp 315-19
3) Anon, "German Artillery Projectiles and Fuzes", Ordnance Bomb Disposal Center, Aberdeen Proving Ground and U S Navy Bomb Disposal School Washington D C (about 1945)
4) Anon, "German Explosive Ordnance" (Bomb Fuzes), TM 9-1985-2 (1953)
5) Anon, "German Explosive Ordnance" (Projectile Fuzes), TM 9-1985-3 (1953).

Fuze Train (HE Train; Artillery Ammunition Train) (Zündersatz) is described in the general section).

The information in Table 17 is taken from Picatinny Arsenal Technical Report No 1555, pp 11-15 and some Chemical Laboratory Reports. (See next page).

"G 3" Fusehead. See Fusehead "G 3".

Guine. See Detonators Used in Fuzes.

Gelatin. See Gelose.

Gallery, Testing. See Versuchsstrecke.

Gasdruckpatronen (Gas Pressure Cartridges). See general section and also the article entitled "Die Entwicklung der Gasdruckpatronen in Deutschland" by E.R. von Herz, in Explosivstoffe, 1954, Heft 5/6, pp 64-8.

Gaseous Metal Treatment, such as chromatizing of iron or steel articles by the diffusion of chromous chloride vapor at high temperature is briefly described in BIOS Final Repts 839 (1946) and 1534 (1946).

Gasless Delay Detonators (Electric). German gasless delay detonators of WWI were usually prepared as follows:

Al or Cu detonator shells (Hülse) having an outside diameter of 7.20 mm (for Al) and a length ranging from 52.5 to 85 mm (depending on the delay required) were thoroughly cleaned and dried before loading.

Tetryl was loaded first in two increments, a total of 0.7g, to serve as a base charge; this was followed by an initiating charge of 0.3g of 60/40 L A /L St mixture and a perforated (reinforcing) cap all pressed at 250 kg/cm^2.

Note: Tetryl, as well as L A and L St, were previously dried to a maximum moisture content of 0.1%.

After keeping the loaded detonators for 3 days at 50° in order to remove all traces of moisture, 50 mg of loose intermediate composition was placed on top of the reinforcing cap.

Note: The intermediate composition (powdered mixture of Sb and $KMnO_4$) forms a loose connection between the delay composition (to be loaded next) and the initiating composition (L A /L St). The intermediate composition burns with a strong flame which facilitates the ignition of L A /L St mixture. Misfires are possible if the delay mixture is placed in direct contact with L A /L St (Cont'd on p 65)

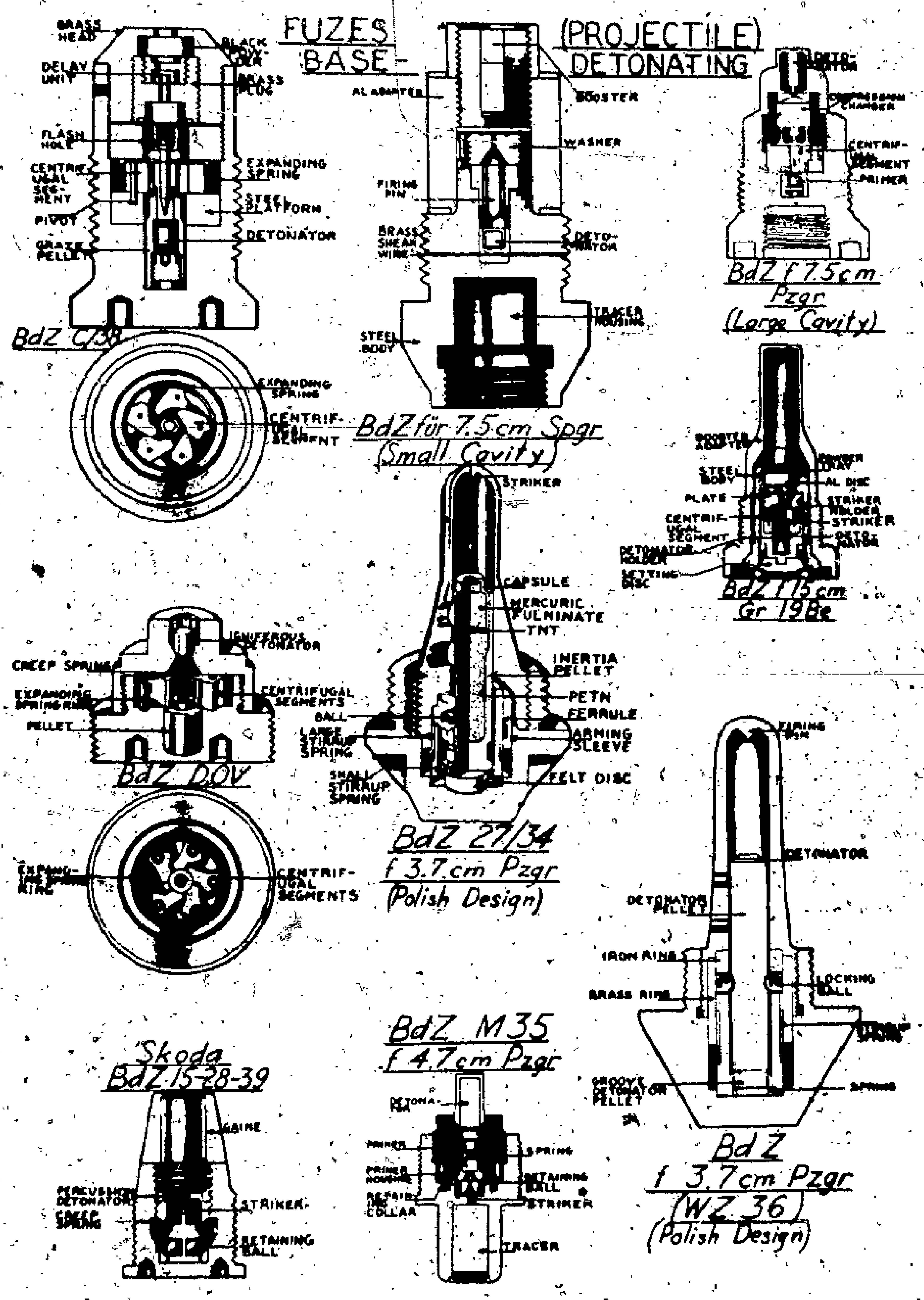


Table 17
Fuze Trains

Primer charge	Detonator charge layers: Upper	Inter-mediate	Lower	Uses
60/34/6-$KClO_3$/Sb_2S_3/ abrasive	L Sc	-	L A	37mm AP shell
Same as above	Black powder (cover charge)	L A	PETN/TNT	47mm AP shell
Same as above	55/45-L A /L Sc	-	PETN	50mm AP and HE shell, 80mm CM shell
Same as above	39/54/7-L A /L Sc /abrasive	-	PETN	88mm AP shell
Same as above	M F	-	50/50-TNT/ tetryl	Land mine
Same as above	63/37-L A /L Sc	-	Tetryl	40mm HE shell
None	L A /Ca silicide	-	PETN	50mm HE shell and HE taper bore shell
None	(24/43/32/1- Black powder/M F /$KClO_3$/ Sb_2S_3 layer(L A /grit)	-	PETN	37mm AP shell
None	82/7/11-L A /Sb_2S_3/ abrasive	-	PETN	37mm and 50mm HE shells
29/40/31-M F/$KClO_3$/Sb_2S_3	L A	-	PETN	47mm HE shell
10/46/34/10-M F/$KClO_3$/ Sb_2S_3/ abrasive	L A	-	PETN	47mm HE shell
54/34/12-$KClO_3$/Sb_2S_3/ grit	L A /L Sc	-	PETN/wax	50mm AP shell
8/60/29/3-M F /$KClO_3$/ Sb_2S_3/ glass	L A /L Sc	-	PETN/wax	75mm AP shell
59/27/10/4-$KClO_3$/Sb_2S_3/C/ abrasive	14/86-L A /L Sc	-	95/5-PETN/ wax	47mm AP shell
Same as above	55/45-L A /L Sc	-	PETN	75mm AP shell
26/37/36/1-M F /$KClO_3$/ Sb_2S_3/glass	L A /L Sc	-	PETN/wax	88mm AP shell
None	65/35/-L A /L Sc	-	RDX	88mm AP shell
None	55/45/-L A /L Sc	-	PETN	80mm HE Mech TE shell
13/45/34/8-M F /$KClO_3$/ Sb_2S_3/ abrasive	55/45/-L A /L Sc	-	PETN	105mm HE How shell
None	94/6-L A /tetracene	-	PETN	A/T Stick-grenade 41
51/24/25-$KClO_3$/Sb_2S_3/ grit	L A /L Sc	-	PETN	50mm Mor bomb
None	(5/76/19-NC/lead oxide/ silicon)over (25/52/23 - $KClO_3$/$PbCrO_4$/silicon)	-	PETN	80mm Mor bomb
14/38/42/6-M F /$KClO_3$/ Sb_2S_3/ glass	M F	-	40/60-tetryl/TNT (pressed)	Tellermine 35
41/41/3/15-L Sc/ $Ba(NO_3)_2$/Sb_2S_3/ Ca silicide	59/39/2-L A / L Sc /graphite	-	PETN	Tellermine 42 or 43
65/35-L A /Ca silicide over PETN	L A /L Sc	-	87/13 -PETN/wax and tetryl booster	[illegible] HoC shell 38, 105mm HoC shell 39
None	94/6-L A /tetracene	-	PETN	A/T Rocket 30
None	94/6-L A /tetracene	-	PETN	80mm A/T,HoC Rocket
None	L A /L Sc	-	PETN	80mm A/T HoC Rocket, 150mm Rocket 41
None	60/40-L A /L Sc	-	PETN	210mm Rocket 42

Abbreviations: AP Armor-piercing; A/T Antitank; BD Base detonating; CM Chemical mortar; F Fuze; HE High explosive; HoC Hollow charge; How Howitzer; L A Lead azide; L Sc Lead styphnate; M F Mercuric fulminate; Mor Mortar; PD Point detonating; PETN Pentaerythritol tetranitrate; T Time; Tellermine Land mine

The next step was to press into contact with the intermediate composition the delay element contg a compressed pulverulent mixture of Sb and $KMnO_4$. The detonator shell was then crimped just above the upper end of the delay sleeve in order to provide a seat for the Mipolam sealing plug.

Note: According to CIOS Rept 24-3, pp 5-6, the gasless delay powder (also called gasless delay fuze powder) consisted of about 70% Sb powder and 30% K permanganate for slow burning, or about 46% Sb and 54% K permanganate for fast burning. The permanganate was ground in a disc or plate crusher mill to approximately 80 mesh. The Sb was ground from lumps in a vibratory ball mill and the powder was transferred by a screw feed into an air separator. The fines which did not exceed 10 microns in size were collected and blended with the permanganate by means of a tumbling mill. The resulting mixture was compressed into tablets in a rotary multiple punch press. (It is assumed that the tablets were formed to give more intimate contact between the ingredients). The tablets were then broken down in a plate crusher mill and the resulting powder used for filling detonators.

The fusehead assembly (see Fusehead Manufacture) consisting of bridge wire, igniter bead, two lead-in wires (insulated by Mipolam) and the Mipolam plug was inserted in the detonator shell in such a manner that the plug rested on the shoulder of the detonator shell formed by crimping. A second crimping was then made above the plug and the lead-in wires were connected to a source of electricity when the detonator was to be fired.

References:
1) A.Ashcroft et al, B I O S Final Rept 833, Item 2, H M S O London (1946),Appendix A3
2) Anon, Manufacture of German Detonators and Detonating Compositions, PB Rept 95,613 (1947) (Section B to L incl).

Gasspurpatronen. See Gasdruckpatronen.

Gegenläufige oder Kumulative Zündung (Running Toward or Cumulative Priming). In order to increase the efficiency of an explosive charge it was initiated simultaneously from the opposite ends, using two electric blasting caps or pieces of detonating fuse.
[A.Stettbacher, Spreng- und Schiessstoffe, Zürich(1948), p 155].

Gelatine-Astralit (Gelatin-Astralite). A plastic low-freezing explosive based on dinitrochlorohydrin (DNCH). Several varieties existed, of which the composition manufactured before WWI by the Dynamit A -G was widely used in shaft sinking by the freezing process and also in other rock work where low-freezing dynamite is desired during the colder parts of the year, such as in building water power plants. It had approximately the following composition and properties: gelatinized dinitrochlorohydrin (DNCH), including NG 30, mixture of DNT and TNT 10, and Am and Na nitrate with wood meal 60%; Trauzl test value 400cc, Pb block crushing 18.0 mm, sensitiveness to initiation required at least a No 3 cap, propagation (gap) using two 25 mm cartridges 20.0 mm, velocity of detonation 7300 m/sec, heat of explosion 1127.5 kcal/kg, temperature of explosion 2334°, density 1.45.

The gelatine-Astralit which was permitted to be transported on German railroads was required to contain gelatinized dinitroglycol 30, aromatic dinitrocompounds 8, aromatic trinitrocompounds 4, Am nitrate and vegetable meal 58%. Its properties were: Trauzl value 415 cc, Pb block crushing 19.0 mm, sensitiveness to initiation required at least No 1 cap, propagation (gap)(using two 25 mm cartridges 50.0 mm), velocity of detonation about 6500 m/sec at a density of 1.45, heat of explosion 1158 kcal/kg, temperature of explosion 2485°, volume of gases at NTP 864.4 l/kg, specific pressure 8733 atm.
Reference: P.Naoúm, Nitroglycerin(1928), pp 378 and 381.

Gelatine-Carbonit (Gelatin-Carbonite). Several varieties of these permissible explosives are described by Naoúm, Nitroglycerin, Baltimore, (1928), pp 407, 411 & 441, as can be seen from Table 18

Table 18

Ingredients and some properties	Gelatin-carbonites: I	III	D	No designation
Am nitrate	61.0	46.4	31.5	41.5
Na nitrate	4.4	7.0	-	-
K nitrate	-	-	5.1	-
NG (mixed with collod cotton)	25.6	10.1	30.0	26.0
Glycerin plus gelatin	4.0	5.0	2.5	6.9
Na chloride	24.0	27.5	30.9	25.5
Vegetable meal	10.0	4.0	-	-
TNT	5.0	-	-	-
Ultramarine	-	-	-	0.1
Oxygen Balance,%	-13.1	+2.2	+5.3	-
Trauzl Test, cc	220	200	225	260
Veloc of Detonation, m/sec	-	-	-	2300

Gelatine-Cheddit (Gelatin-Cheddite). Gelatinous explosives based on chlorates, such as Na chlorate 70, and collod cotton gelatinized with liquid TNT 30%.
Reference: P.Naoúm, Nitroglycerin, Baltimore (1928), p 353.

Gelatine-Dahmenit(Gelatin-Dahmenite). A type of low-freezing gelatinous explosive manufd before WWI.

Table 18a gives two types A and B

Table 18a

Ingredients and some properties	Gelatin-dahmenites: A	B
Dinitroglycerin	27.4	27.4
Collodion cotton	0.6	0.6
Nitrotoluenes	4.5	3.5
Naphthalene	0.5	-
Ammonium nitrate	32.0	32.0
Potassium nitrate	2.0	2.0
Sodium nitrate	5.5	4.5
Alkali chloride	27.5	30.0
Trauzl Test, cc	233	205
Charge limit in firedamp, grams	350	700

Reference: P.Naoúm, Nitroglycerin (1928), p 419.

Gelatine-Donarit (Gelatin-Donarite). A type of gelatinous industrial explosive containing about 50% of Am nitrate, 30% of mixture of dinitrochlorohydrin with nitroglycol and 20% of other ingredients. Its properties are: temp of explosion 3225° C, vol of gases at NTP 803 l/kg, cartridge density 1.45, specific pressure 10100 kg/cm², veloc of deton 6250 m/sec, Trauzl test 380 cc and impact sensitivity with 2 kg weight 20 cm.
(See also Donarit Gelatin Type, under Donarit).
Reference: F.Weichbelt, Sprengtechnik, C. Marhold, Halle/Saale (1953), pp 37 & 375.

Gelatine-Dynamit (Gelatin Dynamite) – the first gelatinous NG explosive. It was prepd by A.Nobel in 1875 (See Swedish Section). The current gelatin-dynamites consist of 30 to 65% of a liquid nitric ester (such as NG) mixed with a small amount of collodion cotton and 80 to 35% of "Zumisch-pulver", called in the U S A "dope".

They may be subdivided into the following types:

A) Gewöhnliches und schwergefrierbares. Ordinary and difficultly freezing (low freezing)

B) Phlegmatisiertes, transportsicheres. Phlegmatized, safe to transport

C) Schlagwettersichere. Safe in the presence of firedamp (permissible dynamites).

To the A type of dynamites belong the blasting gelatin and the dynamites shown in Table 19 with the exception of those which contain only a small amount of NG. Any of these explosives may be rendered low-freezing by incorporating nitroglycol, dinitroglycerin, dinitrochlorhydrin, etc. The following composition, listed by Stettbacher (Ref 4, p 85), may be given as an example of the "schwergefrierbares" dynamite : NG with nitroglycol 62.5, collod cotton 2.5, Na or K nitrate and/or K perchlorate 27.0, and wood meal or rye meal 8.0% with prepared chalk (Schlämmkreide) added 0.5%.

To the B group belong dynamites in which part of the NG is replaced by dinitrochlorhydrin.

Note: Aromatic nitrocompounds have been used in other countries to replace part of the NG.

To the C group belong explosives containing small amounts of NG and appreciable amounts of cooling agents such as alkali chlorides. Dynamites which contain larger amounts of ammonium nitrate (see Ammongelatine) also belong to the permissible group.

Table 19 which follows gives composition and some properties of typical gelatin-dynamites

Table 19

Components and some properties	High-strength gelatin-dynamites				Other gelatin-dynamites					
	Blasting gelatin	81%	80%	75%	No 1	No 2	No 3	No 4 a	No 4 b	No 5
NG	92	75.8	75	70.4	62.5	56 to 61	40.0	40.0	40.0	18 to 20
Collod cotton	8	5.2	5	4.4	2.5	1 to 3	-	-	-	-
Vegetable meal	-	3.8	5	5.7	8.0	3 to 8	6.0	7.0	2.0	2 to 4
TNT & DNT	-	-	-	-	-	0 to 4	10.0	-	-	12
Hydrocarbon	-	-	-	-	-	-	-	-	5.0	-
K nitrate	-	15.2	15	19.5	-	-	-	-	-	-
Na nitrate	-	-	-	-	27.0	-	44.0	41.0	-	-
Alkali nitrates and/or K perchlorate	-	-	-	-	-	25 to 30	-	-	-	-
K perchlorate	-	-	-	-	-	-	-	-	41.0	54
Cooling agents, such as alkali chlorides	-	-	-	-	-	-	-	12.0	12.0	12
Oxygen Balance, %	+0.4	-	-	-	+4.4	-	+7.0	+12.0	+2.5	+11.0
Density	1.6	-	-	-	1.55	-	1.6	1.7	1.8	1.8
Trauzl Test, cc	560	-	-	-	400	-	290	230	330	250
Pb Block Crushing, in mm	24.0	-	-	-	20.0	-	18.0	19.0	20.0	18.0
Max Veloc of Detonation, m/sec	8000	-	-	-	7000	-	6500	6500	6500	6500
Heat of Explosion, kcal/kg(H_2O vapor)	1560	-	-	-	1235	-	1050	850	1150	800
Temp of Expln, °C	3200	-	-	-	2950	-	2800	2500	3000	2650

Note: Due to the shortage of nitroaromatic compounds during WW II the Germans used some commercial dynamites in demolition charges as well as in some hand grenades. (See also Ammondynamit, Ammongelatine, Donarit and Gelatine-Dynamit).

References:

1) P.Naoúm, Nitroglycerin etc., Baltimore (1928), pp 331, 334 and 349-50

2) J.Pepin Lehalleur, Poudres, etc., Paris (1935), p 333

3) Anon, Allied and Enemy Explosives, Aberdeen Proving Ground, Md (1946) pp 151-2

4) A.Stettbacher, Spreng- und Schiessstoffe, Zürich, pp 85-86.

Gelatine-Leonit (Gelatin-Leonite). One of the permissible gelatinous low-freezing explosives manufd by Westdeutsche Sprengstoffwerke at Dortmund [Naoúm, Nitroglycerin (1928), p 418].

Table 20 (Gelatine-Prosperit)

Components and some properties	Designation	
	1	2
DNCH (dinitrochlorohydrin)	20.0	20.0
NG (nitroglycerin)	5.0	5.0
NC (nitrocellulose)	0.5	0.5
DNT (dinitrotoluene)	5.0	5.0
Cereal meal	2.5	2.0
Am nitrate	36.0	30.0
Na nitrate	4.0	10.0
Na chloride	21.0	27.5
K oxalate	6.0	-
Oxygen Balance, %	+0.4	-1.2
Trauzl Test, cc	225	210

(See next page).

Gelatine-Prosperit (Gelatin-Prosperite). According to Naoúm (Ref 1 & 2) gelatin-prosperites were low-freezing gelatinous explosives based on dinitrochlorohydrin. Table 20 lists two such explosives.

(See previous page).

References:

1) Naoúm, Schiess- und Sprengstoffe, Dresden, (1927), p 152

2) Naoúm, Nitroglycerin, Baltimore, (1928), p 418.

Gelatine-Romperit. Same as Gelatine-Donarit [Weichelt, (1953), p 37].

Gelatine-Telsit. See under Swiss Explosives.

Gelatine-Tremonit (Gelatin-Tremonite). Gelatinized, low-freezing explosives, manufd for many years by the Castroper Sicherheitssprengstoffe in Westphalia. E g : a) gelatinized di- and trinitroglycerin 47.5, DNT 5.0, wood meal 5.0, Am nitrate 22.5, and Na nitrate 20.0%; Trauzl value 400 cc; b) gelatinized di- and trinitroglycerin 30.0, DNT 10.0, wood meal 2.0, Am nitrate 40.0, and Na nitrate 18.0%; Trauzl test value 375 cc.

Reference: Naoúm, Nitroglycerin (1928), p 368.

Gelatine-Wetter-Astralit. Gelatinous low-freezing dynamites used prior to WWI: a) dinitrochlorohydrin 20.0, NG 5.0, collod cotton 0.5, DNT 5.0, meal 2.5, Am nitrate 36.0, Na Nitrate 4.0, K oxalate 6.0, and Na chloride 21.0%; Trauzl test 225 cc and oxygen balance + 0.4% (Ref 1); b) dinitrochlorohydrin 16, NG 4.0, collod cotton 0.5, MNB 1.0, DNT 4.0, Am nitrate 7.5, flour or potato meal 7.5, Na nitrate 8.0, charcoal 0.5, castor oil 2, Am oxalate 2.5, and Na chloride 14% (Ref 2).

References:

1) Naoúm, Nitroglycerin, Baltimore, (1928), p 418

2) Thorpe Dictionary, London, v 4 (1940), p 554.

Gelatine-Wetter-Nobelit. A permissible explosive for use in gaseous coal mines: gelatinized NG 30, Am nitrate 26.5, wood meal 0.5, Na chloride 40 and 3% of a 50% aqueous solution of Ca nitrate [A.Stettbacher, Spreng- und Schiessstoffe, Zürich (1948), p 91-2].

Gelatinierfähigkeit von Nitrocellulose (Gelatinizing Ability of NC). See Kast-Metz, (1944) pp 111 & 201-4.

Gelatiniermittel oder Lösemittel. See Gelatinierungsmittel für Nitrocellulose.

Gelatinierung (Gelatinization). See general section.

Gelatinierungsmittel für Nitrocellulose (Gelatinizing Agent for NC). See Kast-Metz (1944) pp 109-162.

Gelatinierverfahren (Gelatinization Proceed). Gelatinization of NC is described in the general section.

Gelatit I (Gelatite I). A mining explosive consisting of 30 to 37.5 Am nitrate, 30 of NG (containing some collod cotton), 0.5 to 1.5 wood flour, 0 to 2 DNT (contg 0 to 50% TNT) and 32% alkali chloride. It was permissible in gaseous coal mines, provided the charge was not higher than 200g. In dusty and non-gaseous mines the maximum charge was 600g.

References:

1) J.Pepin Lehalleur, Poudres, etc, Paris (1935), p 414

2) C.Beyling and K.Drekopf, Sprengstoffe- und Zündmittel, Springer, Berlin (1936), p 100.

Gelbmehl (Yellow Flour). Same as Tetranitrocarbazole.

Gelbmehl S (Yellow Flour S). Same as Tetranitrodiphenylsulfone.

Gelignit II. One of the gelatin dynamites manufactured before WWI: NG 47.5, collod cotton 2.5, K nitrate 37.5, wood meal 3.5 and rye meal 9%. [Naoúm, Nitroglycerin (1928), p 330].

Gelose or **Gelactan** (Carraghan Moss). $(C_6H_{10}O_5)_x$, mol wt $(162.08)_x$. Carbohydrate obtained from agar-agar. Its aqueous solutions were used in some ammonium nitrate explosives for controlling the plasticity, such as in Wetter-Wasagit B: NG 27.8, NC 0.7, Am nitrate 30.5, rock salt 39.5, gelose 0.7, wood meal 0.3, and talc 0.5%.

References:

1) R.Allcroft et al, B I O S Final Rept 833, Item 2, H M S O, London (1946), p A1/11

2) PB Rept 62,877 (1946), Table 1.

Gelsenkirchen Testing Gallery (Schlagwetter-Versuchsstrecke in Gelsenkirchen). See under Testing Galleries in the general section.

Gerät 38. See "DO Gerät 38", under Abbreviations at the end of the German section.

Gerät 040. Same "60 cm Mörser Karl" listed under Weapons.

Gerlich Type Gun (Gerlich Reducing-Bore Gun). Same as Tapered Bore Gun or Squeezebore Gun.

Geschosssplitterprobe (Projectile Fragments Test). See Fragments Density Test.

Geschütz (Artillery Piece, Gun). See under Weapons.

Geschwindigkeit der Druckssteigerung (Rate of Pressure Increase). The relation between pressure and time of burning of propellants may be determined as described in H.Brunswig, Das rauchlose Pulver, Berlin, (1926), pp 215-20. If the rate of burning is great, the propellant is called Schnell (quick) and if the rate is low, the propellant is called Langsam (slow).

Gesilit (Gesilite). Gesilites were permissible explosives used during and after WWI. Table 21 gives two examples

Table 21

Components	Designation	
	No 1	No 2
NG (nitroglycerin)	30.75	30.75
DNT (dinitrotoluene)	5.25	5.25
Am nitrate	-	22.00
Na nitrate	18.00	-
Dextrin	39.00	21.00
Na chloride	7.00	21.00

References:

1) E.Colver, High Explosives, N Y (1918), p 167

2) F.M. Turner, Condensed Chemical Dictionary, Reinhold, N Y (1942), p 289.

Gessner Projectile. According to W.Dornberger "V-2" Viking (1954), pp 122-3, Dr Otto Gessner of Peenemünde developed during WW II extremely slender, fin-stabilized sub-caliber projectiles which could be fired from ordinary gun barrels. It seems that these projectiles were identical with the "arrow projectiles", briefly described under A. These projectiles were used in the 105 mm Antiaircraft Gun (10.5 cm Flak) and in the 280 mm Gun Type 5 (28 cm K-5). It was claimed that by using such projectiles in the Gun K-5 the range was increased from 37 miles, for the ordinary projectile, to 56 miles with the arrow projectile carrying a sabot behind thick-walled fins. With a lighter type of projectile, which instead of a sabot had an obturation skirt attached to its middle, a range of about 90 miles was attained. When using this projectile the lateral dispersion was only about 2 mils. (See also under Arrow Projectile).

GESTEINSSPRENGSTOFFE (Blasting Explosives). These are explosives suitable for blasting rocks, caps, constructions etc, but not for gaseous coal mines. The following types have been used:

Gesteins-Albit. Na perchlorate 80, DNN 12, wood meal 3, phenanthrene 3 and NG 2% (Ref 3, p 129)

Gesteins-Dorfit. Am nitrate 65, TNT 15, K nitrate 5, rye flour 5 and Na chloride 10%; velocity of detonation 4605 m/sec at d 1.17 with a 30 mm diameter confined charge (Ref 2, p 195).

Gesteins-Kornit (Gesteins-Carnite). A type of commercial explosive several varieties of which are given in Table 22

Table 23 (Gesteins-Persalit)

Components and some properties	Designation No 1	Designation No 2
[illegible] perchlorate	35	34
[illegible] nitrate	43	48
[illegible]	8	10
DNN	8	-
Carbon (powder)	-	2
NG	2	-
Wood meal	4	6
Oxygen Balance, %	-0.3	+1.7
Trauzl Test, cc	330	325

Gesteins-Westfalit (Gesteins-Westphalite). An antigrisou type explosive consisting of Am nitrate 84.5, DNT 12.0 and Al 3.5% (Ref 2, p 114).

References:

1) A.Marshall, Explosives, Churchill, London, v 1(1917), p 384
2) E.Barnett, Explosives, Van Nostrand, N Y (1919), p 114
3) P.Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), pp 129,133
4) P.Naoúm, Nitroglycerin etc, Williams & Wilkins, Baltimore (1928), p 428
5) C.Beyling & K.Drekopf, Sprengstoffe und Zündmittel, Springer, Berlin (1936)
6) T.L.Davis, The Chemistry of Powder and Explosives, Wiley, N Y (1943), p 364.

Table 22 (Gesteins-Kornit)

Components and some properties	No 1 Ref 3,p129	No 2 Ref 3,p129	T1 Refs 3&6	T2 Refs 3&6
Na chlorate	76.0	83.0	72.0	75.0
Mononitronaphthalene (MNN)	5.0	8.0	-	-
Dinitronaphthalene (DNN)	5.0	-	-	-
DNT & TNT	-	-	20.0	20.0
Nitroglycerin (NG)	4.0	3.0	4.0 to 4.0	-
Wood meal	2.0	1.0	-	-
Vegetable meals	-	-	1.0 to 2.0	1.0 to 2.0
Paraffin	8.0	5.0	3.0 to 4.0	3.0 to 4.0
Oxygen Balance	-	-	+3.0%	+1.9%
Trauzl Test	-	-	290cc	280cc
Pb Block Crushing	-	-	20 mm	20 mm
Sensitiveness to Initiation	Required at least :		No 3 cap	No 1 cap
Gap Test (using 25 mm cartridges)	-	-	8 cm	8 cm
Veloc of Detonation	-	-	5000 m/sec	4300 m/sec
Density of Cartridge	-	-	1.57	1.46
Heat of Explosion	-	-	1219 cal/g	1241 cal/g
Temp of Explosion	-	-	3265°C	3300°C

Gesteins-Permonit oder Permonit I. Perchlorate explosive manufactured before WWI by the Sprengstoff A-G Carbonit for use in potash and ore mines: K perchlorate 30, Am nitrate 40, Na nitrate 7, TNT 15, flour 4, wood meal 3, and jelly 1%. Its Trauzl test value was 320 cc, gap test 7.0 cm and sensitiveness to impact with a 2 kg weight 70 cm (Ref 1).

Gesteins-Persalit (Gesteins-Persalite). A type of commercial explosive described in Ref 3, p 133. The composition and some properties of these explosives are given in Table 23.

Gestreckte Dynamit (Stretched Dynamite). See under Füllstoffe.

Gewehr (Rifle). See under Weapons.

Gewehr 43. German semi-automatic rifle, caliber 7.92 mm, developed in 1943. This rifle incorporated some features of a similar Russian weapon, particularly the Degtyarev LMG (light machine gun) and the Tokarev semi-automatic rifle. The Gewehr 43 weighed 9.75 lbs together with a 0.25 pound sling and a 0.4 pound magazine. [M.Johnson, Jr, Ordnance 29, 306-310, (1945)].

Gewerblichesprengmittel (Industrial or mining explosives). See Commercial Explosives.

Gewichtsverlustprobe (Loss of Weight Test) to determine the stability of an explosive or a propellant, is described in Kast-Metz (1944), p 246 etc.

Gichtstaub (Flue Dust or Blast Furnace Dust). It was used as a component of liquid air explosives. Kast-Metz (1944), p 467).

Glasmine 43 (Glass mine 43). See under Landminen and also TM 9-1985-2 (1953), p 275.

Glide Bomb (Gleitbombe) is a streamlined missile provided with wings and stabilizers to allow it to glide towards a target in free flight, after it is released from a plane flying in approximately horizontal position.

The bomb is used to attack targets at a greater horizontal distance from the releasing plane than would be attacked by normal bombs.

This method of bombing is designed in order to keep the releasing plane out of the range of enemy's AA guns.

A short description of principles of a glide bomb may be found in the following paper:

E.W.Spender, "Untersuchung der Seitenstabilität einer Gleitbombe mit einer automatischen Steuerung ohne Voreilung", Zentrale für Wissenschaftliches Berichtswesen der Luftfahrtforschung des Generalluftzeugmeisters (ZWB), Berlin-Aldershof, Forschungsbericht Nr 1819, May (1943) (Included are 12 references).

Note: English translation is available as Technical Memorandum 1248 of the National Advisory Committee for Aeronautics August 1950.

Glycerin (Glyzerin). See general section.

Note: According to M.L.Sheely, "Synthetic Glycerin", BIOS Miscellaneous Report No 24, (1948), the Ludwigshafen Plant of the IG Farbenindustrie manufactured synthetic glycerin during WW II by the "Five Stage Method", starting from propanol, chlorine, Na carbonate and Na hydroxide. A brief description is included in the above Reference.

Glycerogen. A colorless, viscous, glycerin-like liquid consisting of about 35% glycols, 35% glycerin, 25-28% hexitol, erythritol and other compounds. It can be prepd by continuous catalytic hydrogenolysis of sugar at 200° and 325 atmospheres. The detailed process, operated commercially at the Höchst Plant of IG Farbenindustrie, is described in Ref 1.

Glycerogen was used as a substitute for glycerin in cellulose films, sausage casings, printing pastes, pharmaceuticals, etc and its nitrated product was used as a substitute for NG in dynamites.

References:

1. M.L.Sheely, Glycerogen, a Substitute for Glycerin, BIOS Miscellaneous Report No 23, (1948)
2. F.M.Turner, Condensed Chemical Dictionary, Reinhold, N Y (1950), p 320.

Glykol (Glycol) (abbrev here to Gc). See general section.

Glykolnitrat (Nitroglycol, abbreviated to NGc). See general section.

Glyzerin oder Glycerin (Glycerin, abbreviated to G). See general section.

Glyzerintrinitrat oder Glycerintrinitrat (Nitroglycerin, abbreviated to NG). See general section under Glycerin.

GM-1 (Liquid Nitrous Oxide) was used as a fuel booster for airplane engines (CIOS 25-18, p 5).

GP (Powder). A powdered sodium picrate combined with a binding agent such as Igetex SS (copolymer of butadiene and styrene). It was used as a propellant in Panzerfaust ammunition (CIOS 25-18, p 28).

"G" Pulver ("G" Propellant) (Known in the German Air Forces as "K" Pulver). It is a "cool" smokeless propellant developed before WW II by Gen Uto Gallwitz and collaborators.

Historical:

The use of nitroglycerin (NG) propellants had the following disadvantages:

a) Glycerin needed as the starting material for NG was obtained in those days from food materials contg fats and oils which were in short supply during the war.

Note: With the development of synthetic methods of manuf of glycerin there probably will be no shortage in future wars.

b) The manuf of NG propellants involved some danger to personnel, particularly during the rolling and extruding operations

c) NG is comparatively a slow and poor gelatinizing agent for NC

d) NG propellants are "hot", i e they have a high heat of combustion and a high flame temperature which results in a rapid erosion of the gun barrel and a decrease in its serviceable life.

Note: The marked effect of the heat of combustion on the gun barrel, (erosion), is shown by the following example: a gun using a propellant with 950 kcal/kg was good for only 1700 firings, while one with 820 kcal/kg could stand 3500 firings.

Due to the above disadvantages of NG propellants, work was started in Germany about 1934 under the direction of Gen U. Gallwitz to develop a propellant which would be less erosive than NG propellants and at the same time possess the high ballistic potential required for muzzle velocities of the order 3300 ft/sec.

At first nitroglycol (ethyleneglycoldinitrate) (EGDN) was tried as replacement for NG, but this proved unsuccessful due to the extreme volatility of EGDN even at moderate temperatures. Then, in 1935, Gen Gallwitz proposed use of nitrated "Polyglykol", a product easily available from non-food materials. Polyglycol, which is a mixture of diethyleneglycoldinitrate (DEGDN), (called in Germany Diglykol) with a small amount of EGDN, was considerably less volatile than straight EGDN and although it was more volatile than NG, it could be used in moderate climates such as in Europe. It proved however, to be unsuitable for tropical climates, such as in Africa.

Polyglycol (or straight DEGDN) was a better gelatinizer for NC than NG, but the most important fact was that it produced considerably "cooler" (calorific value about 690 kcal/kg) propellants than it was ever possible to obtain with NG. The diminished erosion prolonged the life of gun

barrels to a much greater degree than was expected. (See under Erosion of the Bore).

The new propellant was called "G" Pulver (G stands for the first letter of Gallwitz).

Due to the fact that "Polyglykol" (or straight DEGDN) is a good gelatinizer for NC, it was possible to prepare propellants more homogeneous than NG propellants and with smoother surface grains. Manufacture of "G" propellants, especially the rolling operation, was much easier and less dangerous and no rolling flaws (often observed in NG propellants) were observed. Another advantage of G propellants was that they permitted the incorporation, without becoming brittle, of materials which do not take part in the gelatinization, such as K sulfate (flash reducer), nitroguanidine (NGu), etc (See also "Gudolpulver").

Being a good gelatinizer, DEGDN may be used in smaller quantities than NG and in a wider range. For instance, while the amount of NG should be 40-45% for optimum results, DEGDN may be used in the range of 20 to 45%, the remainder being NC stabilizer (such as centralite, or acardite) and one of the following: urethanes, phthalates, flash reducers (such as K sulfate or NGu), vaseline, graphite, Mg oxide, etc.

One such propellant: 61.53% of NC (blend of soluble and insoluble NC giving an average nitrogen content 12.2%), 26.37 of DEGDN 7.50 of ethyl centralite, 1.60 of vaseline, 0.65 of phthalate, 0.25 of Mg oxide, 0.1 of graphite and 2.00% of K sulfate had a calorific value of 690-700 kcal/kg as against 820-950 kcal/kg for NG propellants.

As was mentioned above, the DEGDN is more volatile than NG (4-5 times more volatile) and is unsuitable for tropical climates.

Inasmuch as the German troops had trouble with "G" propellants during the African campaign, Gen v Gallwitz proposed using the nitrated product of triethyleneglycol (TEG), (called Triglykol in Germany). This nitrated product (TEGDN) was only slightly more volatile than NG (about 1½ times) and was quite suitable for hot climates. The replacement of DEGDN by TEGDN permitted the production of propellants with even lower calorific value than the ordinary "G" propellants. For instance one containing 58.55% NC (a blend with an average N content of 12.2%) 25.10 TEGDN, 12.00 ethyl centralite, 0.25 MgO, 0.10 graphite, and 4.00% K sulfate had a calorific value of 650 kcal/kg.

TEGDN possesses the same advantages from the point of view of its gelatinizing properties as DEGDN and likewise permits the incorporation of non-gelatinizers such as K sulfate and NGu.

"G" propellants are slow burning and are efficient in weapons where a projectile remains in the barrel long enough for complete combustion of the propellant. All kinds of guns large howitzers and mortars are in this class. All of these weapons have sufficiently long barrels for complete combustion of the powder. "G" propellants in flake form were found unsuitable, however, in medium and small caliber howitzers and mortars because a projectile does not remain for a sufficient time in the barrel for complete combustion of the propellant. In these cases "Gudol" propellants were found to be quite suitable. (See also "Gudolpulver", Erosion of the Bore and under Propellants).

References:

1) Uto Gallwitz, Die Geschützladung (Propelling Charge) Heereswaffenamt, Berlin (1944) (English translation is available).

2) Q.V.Strickland et al, General Summary of Explosive Plants, PB Rept 925 (1945), p 13 and Appendix 9, p 90.

3) H.H.M.Pike, Report on Visit to Düneberg Factory of D A-G. CIOS Rept 31-68 (1946), pp 4-5.

GRANATE (Gr oder gr). The term "Granate" is used in Germany as a base word for various types of rounds. By adding a prefix and/or a suffix to the word the exact nature of the projectile is indicated. E g:

Sprenggranate	Sprgr	HE shell
Sprenggranate 41	Sprgr 41	HE shell for tapered bore gun
Nebelgranate	Nbgr	Smoke shell
Gewehrgranate	Gewgr	Rifle grenade
Handgranate	Hdgr	Hand grenade
Panzergranate	Pzgr	Armor-piercing (AP) shell
Panzergranate 39	Pzgr 39	APCBCHE (Armor-piercing capped, ballistic cap, high explosive) shell
Panzergranate 40	Pzgr 40	AP shell with a tungsten carbide core
Panzergranate 41	Pzgr 41	AP shell with a tungsten carbide core for tapered bore gun
Gewehrsprenggranate	Gewsprgr	Antipersonnel rifle grenade
Gewehrpanzergranate	Gewpzgr	Antitank rifle grenade
Gewehrpropagandagranate	———	Propaganda rifle grenade
Gewehrfallschirmleucht granate	———	Illuminating parachute rifle grenade
Granate Beton	GrBe	Anticoncrete shell
Granate Hohlladung	GrHL	Hollow charge shell

German Artillery rounds of ammunition may be divided into Patronenmunition and Kartuschmunition:

A) Einheitsmunition oder Patronenmunition (One-piece ammunition or cartridge ammunition). It is an ammunition, the complete round of which may be loaded into the weapon in one operation. This corresponds to American fixed ammunition. The complete round consists of a cartridge case containing a primer and a propelling charge. The case is permanently crimped to the projectile.

E g: Rounds used in AA guns, caliber 20 mm, 28 mm, 30 mm, 37 mm, 40 mm, 42 mm, 50 mm, 75 mm, 88 mm, and 105 mm.

Note: The Germans designated the caliber of guns in centimeters but we designated them in millimeters in order to conform to the American practice

B) Kartuschmunition oder Getrenntemunition (Separated cartridge ammunition) is an ammunition somewhat intermediate between American semi-fixed and separate-loading ammunition. It consists of a projectile which is placed into the weapon first and a cartridge case (containing a primer and one or several bags with propelling charge), which is loaded into the breach afterwards. The cartridge case is not fixed to the projectile. The number of bags with propellant could be varied, according to the range requirement, at the place of firing.

Note: The Germans employed cartridge cases for all their ammunition in order to prevent the escape of gases to the rear of the weapon when the breach is opened; they never used the rounds corresponding to the American separate loading ammunition.

The Kartuschenmunition was used in some 75 mm rounds as well as in 105 mm, 150 mm, 170 mm, 210 mm, 240 mm, 280 mm, and 353 mm guns, or howitzers.

The German Artillery projectiles as well as numerous captured Austrian, Belgian, Czech, Dutch, French, Polish, Rumanian, Russian and Yugoslav projectiles used by the Germans during WW II are briefly described in TM 9-1985-3, pp 358-544. (See also Smoke Projectiles).

Following is the list of these projectiles, arranged by calibers together with the references to TM 9-1985-3,

1) 20 mm included: Oerlikon AP, Mauser AP, Solothurn AP, Oerlikon HE, Mauser HE and Solothurn HE are described in TM 9-1985-3, pp 358-60

2) 28/20 mm included: HE 2.8/2.0 cm SprgrPatr and AP PzGr used in Tapered Bore Gun, PzB 41 (pp 371-3)

3) 30 mm included: AP, HE, HE-T, AP with Core and Inert-Loaded projectiles used in Solothurn AC Guns (pp 379-82)

4) 37 mm included:
- a) HE-T (3.7 cm Sprgr L'spur) used in Naval C/30 Gun (p 382)
- b) AP Without Cap (3.7 cm Pzgr) used in Pak (p) captured from the Polish (p 382)
- c) Rodded Bomb (3.7 cm Stielgranate 41) used in Pak 41 (p 383)
- d) AP Without Cap (3.7 cm PzgrPatr 18) used in Flak 18 and Flak 36 (p 384)
- e) HE (3.7 cm SprgrPatr 40) used in Pak (p 385).
- f) AP Without Cap (3.7 cm PzgrPatr) used in Pak (p 386)
- g) HE (3.7 cm SprgrPatr umg) used in Pak (p 386)
- h) HE (3.7 cm SprgrPatr C/30) used in C/30 Gun. (p 388)

5) 40 mm included: HE (4 cm SprgrPatr) and HE-Inc (4 cm Br Sprgr Patr) used in Flak 28 (pp 388-9)

6) 42/28 mm included:
- a) HE (4.2-2.8 cm SprgrPatr L Pak 41) used in L Pak 41 (Tapered Bore Gun) (p 374)
- b) AP With Core (4.2-2.8 cm Pzgr Patr L Pak 41) used in L Pak 41 (Tapered Bore Gun) (p 374)

7) 47 mm included:
- a) AP With Tungsten Carbide Core Arrowhead Design (4.7 cm PzgrPatr 40) used in Czech design tapered bore guns Pak (t) and K36 (t) (p 375)
- b) HE (4.7 cm SprgrPatr 36) used in some Czech design guns (p 390)
- c) HE Austrian design [4.7 cm SprgrPatr (ö)] used in Böhler K (ö) (p 391)
- d) APC [4.7 cm PzgrPatr 36 (t)] used in Czech design guns Flak 37 (t) and Pak (t) (p 392)

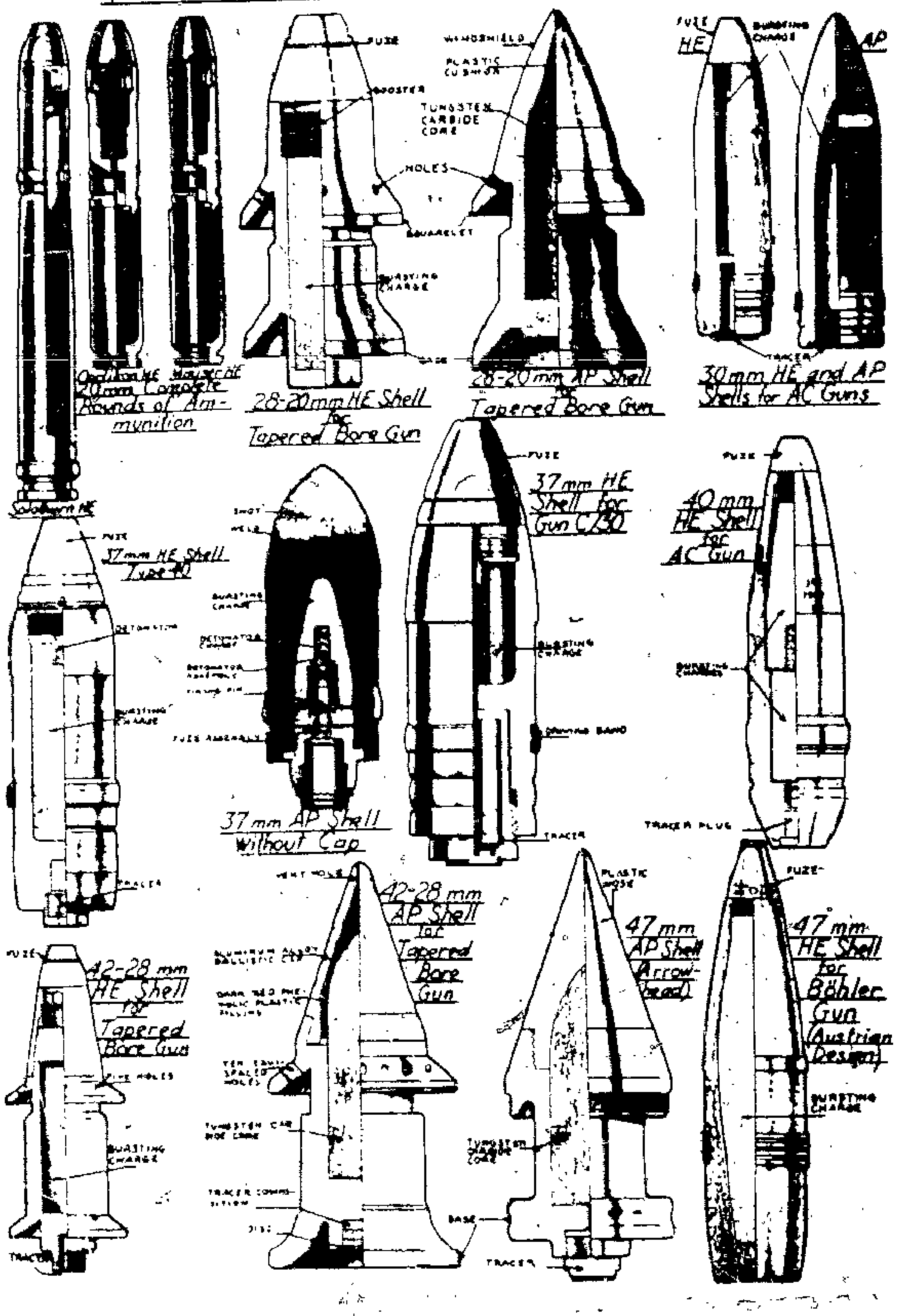
8) 50 mm included:
- a) AP With Tungsten Carbide Core, Arrowhead Design (5 cm PzgrPatr 40 KwK) used in the Tank Gun, 5 cm KwK (p 376)
- b) AP Without Cap (5 cm PzgrPatr KwK) used in KwK (p 394)
- c) HE (5 cm Sprgr Patr 38) used in KWK 39 and Pak38 (p 395)
- d) APC (5 cm PzgrPatr KwK) used in the same guns as above (p 395)
- e) HE-Inc-T (5 cm Br SprgrPatr 41 L'spur) used in Flak 41 (p 397)
- f) HE Mortar projectile used in 5 cm LGrW 36 (p 550)

9) 75 mm included:
- a) AP With Tungsten Core, Arrowhead Design (7.5 cm PzgrPatr 41) used in the Antitank Gun, Pak 41 (p 378)
- b) HE (7.5 cm SprgrPatr KwK 34) and AP With Ballistic Cap and AP Cap (PzgrPatr 39 KwK 40) used in KwK, KwK 40, StuG 40 and Pak 40 (p 398)
- c) HoC Type 39 [7.5 cm GrPatr 39 (HL)] used in GebK 15 (p 399)
- d) HoC [7.5 cm GrPatr 38 KwK (HL)] used in KwK, StuG, KwK 40, StuG 40, GebK 36 and the Recoilless Gun for Airborne Troops (LG 40) (p 400)
- e) HoC [7.5 cm GrPatr KwK (HL/B)] used in the same guns as above (p 401)
- f) Smoke (7.5 cm Nbgr Patr KwK) used in the same guns as above (p 402) (See also Smoke Projectiles)
- g) HE (7.5 cm GebG 15 Aluminium) used in GebK 15 (p 403)
- h) HoC (7.5 cm Igr) used in LIG 18 and L Geb IG 18 (p 404)
- i) HE (7.5 cm Igr 18 AZ 23 hA) used in LIG 18 and L Geb IG 18 (p 405)
- j) HE (7.5 cm SprgrPatr 75/50) used in Skoda Dual-Purpose Gun (p 406)
- k) HoC, Type 38 (7.5 cm GrPatr 38 HL/A) used in LFK 18 (p 407)
- l) AP [7.5 cm Pzgr 40 (W) Pak 40] used in Pak 40 (p 408)
- m) APC (7.5 cm PzgrPatr KwK 38) used in KwK, StuG, LFK and in Recoilless Gun for Airborne Troops (p 409)
- n) HoC (7.5 cm GrPatr 38 HL/A KwK) used in KwK 38, KwK 40, LFK 18, GebK 36, StuG 40, Pak 40, FK 16 and Recoilless Gun 40 (p 409)
- o) APC (7.5 cm Pzgr 39 FES) used in Pak 40, 40/1, 40/2 and 40/3 (p 410)
- p) HoC (7.5 cm GrPatr 38 HL/B) used in same guns as given under (n) (p 411)
- r) HE (7.5 cm SprgrPatr 34) used in StuK 40 (L/43), StuK 40 (L/48) and Pak 40, 40/1, 40/2 and 40/3 (p 417)
- s) HoC (7.5 cm Jgr 38 HL/A) used in LJG 18 and L GebG 18 (p 425)
- t) Projectiles used in captured 75 mm Belgian, Dutch, French, Polish and Yugoslav guns are described on pp 410, 413, 415, 419, 420, 421, 423 and 425 of TM 9-1985-3

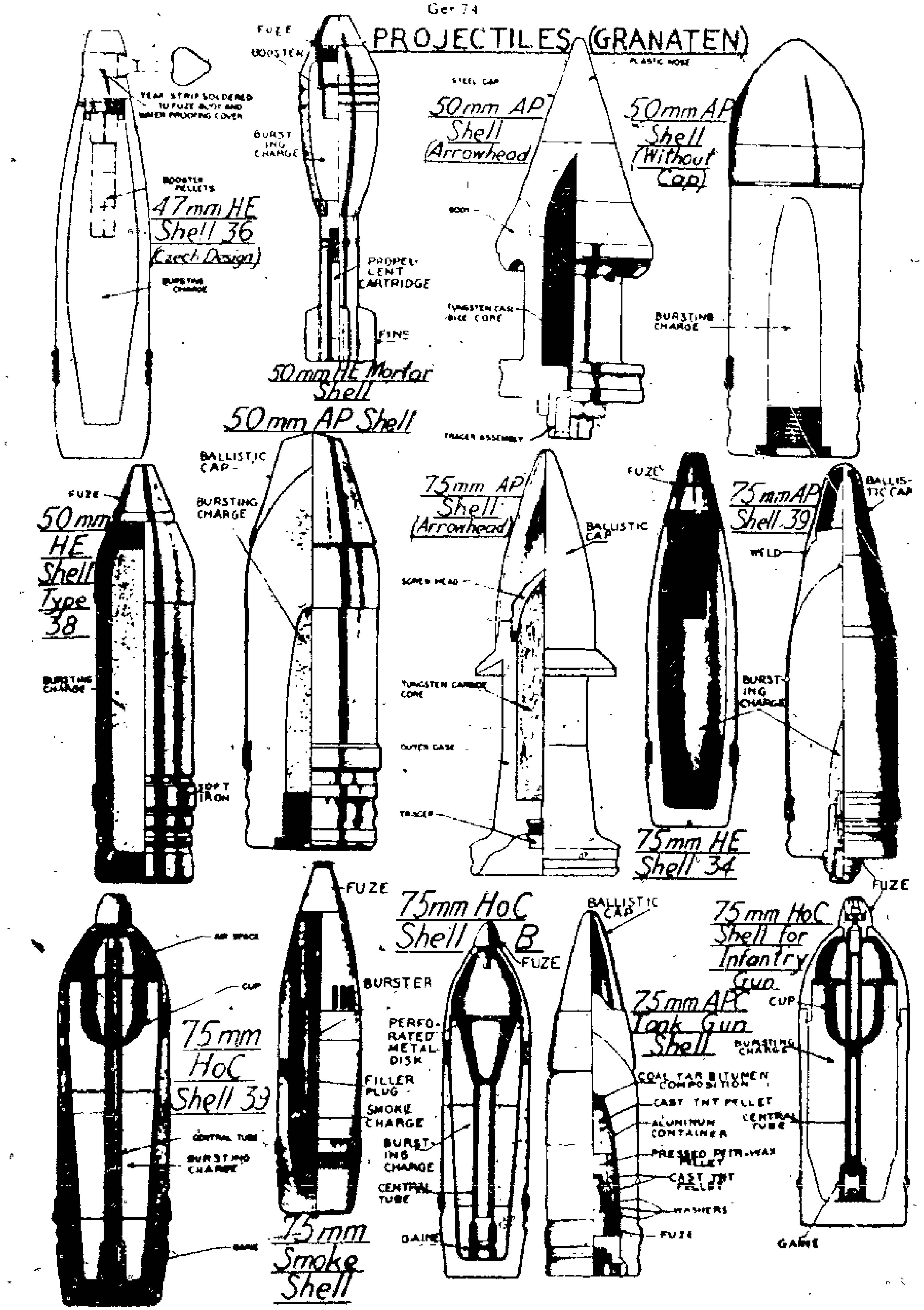
10) 75/58 mm was the Brandt Sabot projectile developed in France by E.Brandt (p 369)

11) 76.2 mm included the following projectiles used in captured Russian weapons:
- a) HE (7.62 cm Sprgr 284/4) used in GebK 307(r) (p 426)
- b) HE (7.62 cm Sprgr Patr 39) used in FK 36 (r) and Pak 36 (r) (p 426)
- c) AP (7.62 cm PzgrPatr 40) used in FK 296 (r) FK 36 (r) and Pak 36 (r) (p 427)
- d) APC (7.62 cm PzgrPatr 39 rot) used in Pak 36 (r) (p 428)
- e) HE (7.62 cm Sprgr 280/2) used in JKH 290 (r) (p429)
- f) HE (7.62 cm Sprgr 284/4) used in GebK 307 (r) (p 430)
- g) HoC (7.62 cm Gr 38/2 HL/B) used in JKH 290 (r) (p 430)
- h) HE (7.62 cm Sprgr 39/2) used in JKH 290 (r)

PROJECTILES (GRANATEN)



PROJECTILES (GRANATEN)



12) 76.5 mm projectiles were used in captured Austrian, Czech and Yugoslav 7.65 cm weapons (pp 432-435)

13) 80 mm included:

a) HE Mortar proj (8 cm Wgr 38 and Wgr 39) used in sGrW 34 (p 529)

b) Colored Smoke proj (8 cm Wgr 38 Deut) used in sGrW 34 (p 533). (See also Smoke Projectiles)

c) HE, Smoke proj (8 cm Wgr 34 Nb) used in Mortar, MGrW 34 and KzGrW 42 (p 532).

14) 83.5 mm included: 8.35 cm Pzgr (t) and Gr 23/20 (t) used in captured Czech AA Gun, Flak M/22 (t) (pp 436-7)

15) 88 mm included:

a) APC (8.8 cm PzgrPatr 39) used in Flak 41 (p 438)

b) HE [8.8 cm SpgrPatr L/4.5(Kz)] used in Flak 18, Flak 36 and Flak 37 (p 438)

c) AP (8.8 cm Pzgr 41) used in Flak 36 and Flak 41 (p 439)

d) AP with Tungsten Carbide Core, Type 40 (8.8 cm Pzgr 40) used in Flak 36 and Flak 41 (p 439)

e) HE (8.8 cm Spgr Patr (L/4.7 FES) used in Flak 41 and Flak 43 (p 441)

f) APC (8.8 cm Pzgr Patr mBdZ) used in Flak 18, Flak 36 and Flak 37 (p 441)

g) HE, Type 43 (8.8 cm SpgrPatr 43) used in KwK 43, Stuk 43 (L/71) and Pak 43 and 43/71 (L/71) (p 442)

h) HE (8.8 cm Pzgr 39/43) used in Pak 43 and Pak 43/41 (p 442)

i) HE (8.8 cm Spgr Flak 41) used in Flak 41 (p 443)

j) HoC (8.8 cm GrPatr HL) used in KwK 36 (L/56) (p 444)

k) HE (8.8 cm Spgr L/4.5) used in KwK 36, Flak 18, Flak 36, Flak 37 and in Modified Russian AA Gun 8.5/8.8 cm Flak 39 (r) (p 444)

l) HE, with Controlled Fragmentation (8.8 cm Spgr L/4.5 ZtZ) used in KwK 36 (L/56) (p 445)

m) AP (8.8 cm Pzgr) used in Flak 18, 36, 37 and in Flak 39 (r) (p 446)

n) AP (8.8 cm Pzgr 39/1) used in Pak 43, Pak 43/41 (L/71) and StuK 43 (L/71)(Self-propelled gun)(p 446)

o) AP (8.8 cm Pzgr 39) used in Flak 18, 36 & 37, KwK 36 (L/56) and in Flak 39 (r) (p 448)

p) Incendiary Shrapnel (8.8 cm Gr Br Schr Flak) used in Flak 18, 36 and 37 (p 448)

16) 100 mm included:

a) HoC proj Type HL/B and Type HL/C are described in TM 9-1985-3, pp 450-1, but their uses are not given

b) HE Czech proj [10 cm DoppZGr M 21 (t)] used in captured Czech, Polish and Yugoslav Light Field Howitzers (p 451)

c) HE Yugoslav proj [10 cm Spgr DoppZ 311 (j) and Spgr (AZ) 310 (j)] used in captured Czech, Polish & Yugoslav Light Field Howitzers and Mod 28 Yugoslav Mountain Howitzer (p 452)

d) HE Czech proj [10 cm DoppZGr 30 (t)] used in Czech, Polish and Yugoslav Light Field Howitzers (p 453)

e) HE Polish proj [10 cm StgGr (p)] used in Czech, Polish and Yugoslav Light Field Howitzers (p 455)

f) HE German proj (10 cm Spgr 38) used in Czech, Polish and Yugoslav Light Field Howitzers (p 454)

g) HE Mortar proj (10 cm Wgr 37) used in NbW 35 (p 533)

17) 105 mm included:

a) HE (10 cm Gr 19) used in K 18 (p 456)

b) HE used in K 17/04 nA and K 17 (p 457)

c) AP used in several Light Field Howitzers (pp 457 and 459)

d) HE (10 cm Spgr L/4.4) used in Flak 38 (p 467).

e) AP-T (10 cm Pzgr rot) used in Flak 38, Flak 39, sK 18 and sKT (p 468)

f) AP (10 cm Pzgr rot L'spur) used in Light Field Howitzer (LFH 16). (p 470)

g) HE used in Light Field Howitzer LFH 16) (p 471)

h) Smoke used in Howitzers (LFH 16, LFH 18, LFH 18MB and StuH 42) (p 472)

i) HE for Long Distance Use in Light Field Howitzers 18 with Muzzle Brake (LFH 18MB) (p 473)

j) HoC Type A, HoC Type B and HoC Type C used in the same Light Field Howitzers as listed under (h) (pp 474-77)

k) HE, Model 15, Model 23 and Model 28 used in the 10 cm Skoda Howitzer (pp 477-80)

l) HE (10 cm Spgr Patr L/4.4 Kz) used in Flak 38 and Flak 39 (p 480)

m) HE (10 cm Gr 19 Kz 13) used in sK 18, KT and lgKT (p 481)

n) HE proj with disintegrating band is described briefly on p 369 of TM 9-1985-3

o) Projectiles used in captured 105 mm Belgian, French, Polish, Russian and Yugoslav guns are described on pp 459, 461 and 463-467 of TM 9-1985-3

p) HE (10 cm FHGrStg mR 11) used in Light Field Howitzers: FH 18, FH 18/1, FH 18/2, FH 18 mM, FH 18/39 and FH 18/49 (p 536)

18) 122 mm included HE projectile 12.2 cm Spgr FEW (r) used in captured Russian guns K 390/1 (r) and K 390/2 (r) (p 481)

19) 128 mm included:

a) HE (12.8 cm SpgrPatr L/4.5), described briefly on p 482

b) AP (12.8 cm Pzgr FES) used in Flak 40 (p 483)

c) AP (12.8 cm KPS) used in Flak 40 (p 483)

d) AP (12.8 cm Pzgr 43) used in Flak 44, self-propelled (p 484)

20) 150 mm included:

a) HE With Disintegrating Bands, Sabot Type (p 370)

b) HE [15 cm AZGr 37 (t)] used in Czech Medium Howitzer sFH 25 (t) (p 485)

c) HE (15 cm KGr 42) used in K 18 (p 486)

d) HoC (15 cm Jgr 39 HL/A) used in StuH 43(L/12) and sJG 33 (p 486)

e) A/C (15 cm Gr 19 rot Be) used in K 18 and K 39 (p 487)

f) Czech projectiles, such as 15 cm GrM 25 (t) (p 488), 15 cm AZGrM 34 (t) (p 488), 15 cm MinGr M 13/19 (t) (p 489), 15 cm MinGr 28 (t) and 15 cm MinGr M 28 (t) (p 490) used in captured Czech Field Howitzers

g) HE (15 cm Jgr 38 FES) used in the Assault Howitzer StuH 43 (p 491)

h) AP (15 cm PzSpgr L/37 mHbe) used in K 18 (p 491)

i) HE (15 cm Gr 36 FES) used in sFH 18 (p 492)

j) HoC (15 cm Gr 19 HL) used in sFH 18 and sFH 13 (p 492)

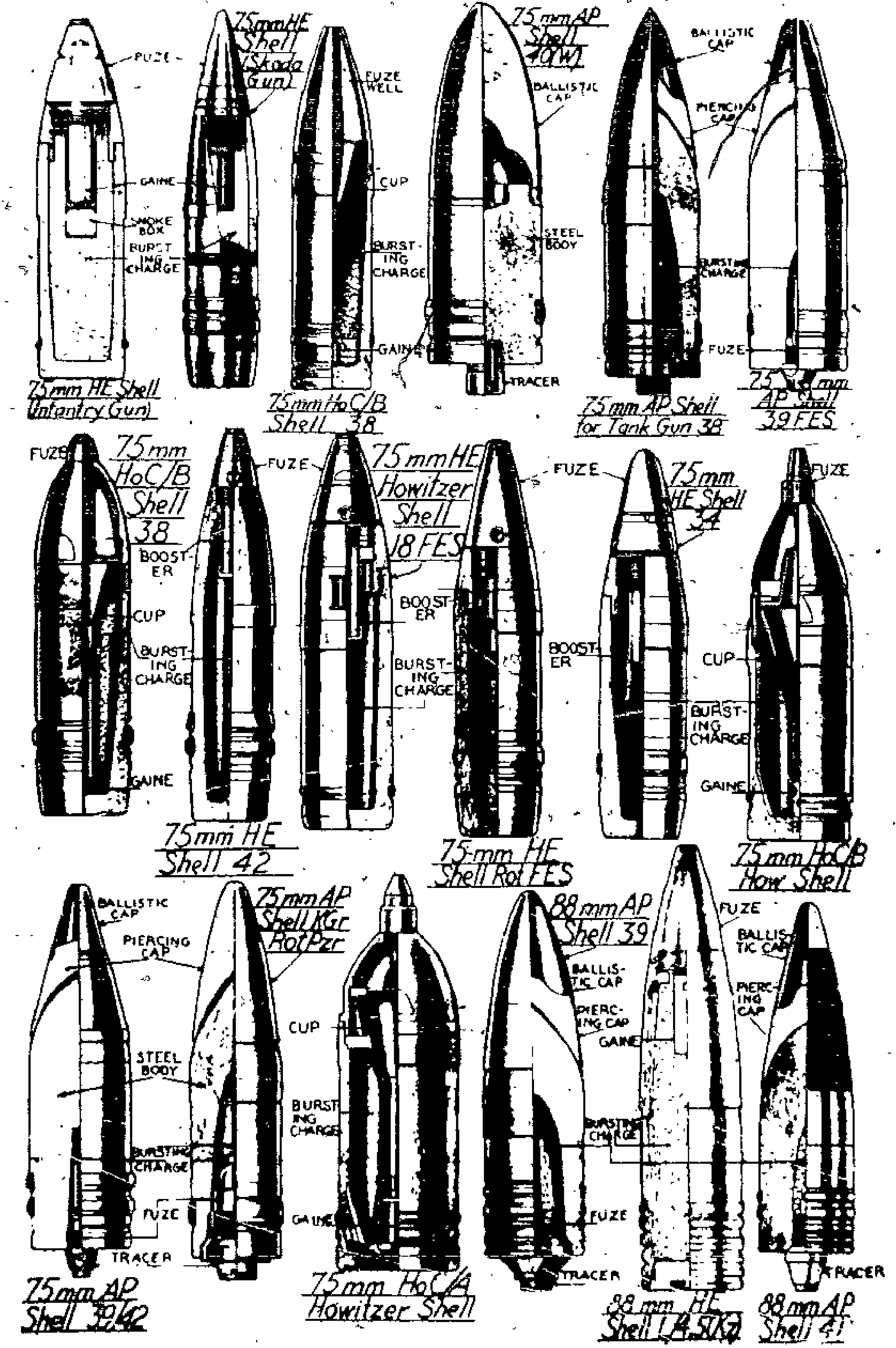
k) A/C (15 cm Gr rot Be) used in K 18, K 39 and in K (E) (p 493)

l) HE (15 cm Gr 19m Zdlg 36) used in sFH 18 (p 494)

m) HE proj of cast steel (15 cm Gr 19 Stg) used in sFH 18, sFH 13 and sHT (p 495)

n) Smoke (15 cm Gr 19 Nb) used in sFH and sFH 13 (p 497)

PROJECTILES (GRANATEN)



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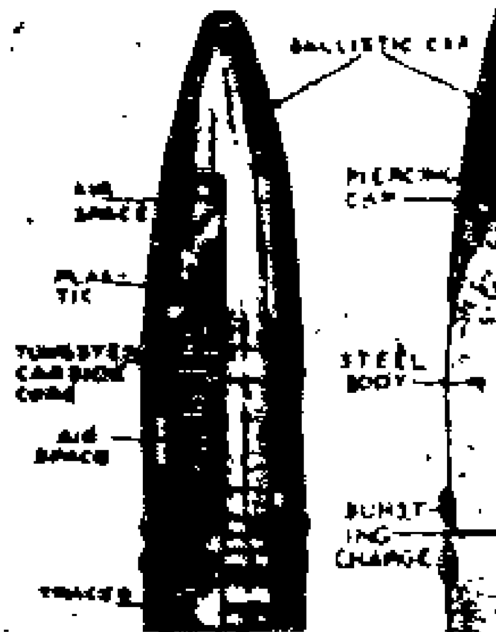
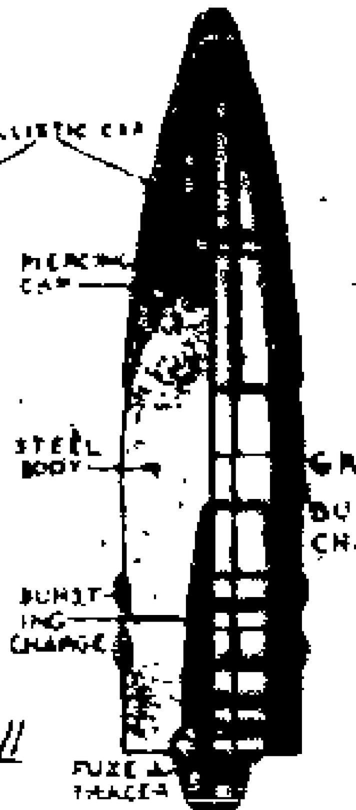
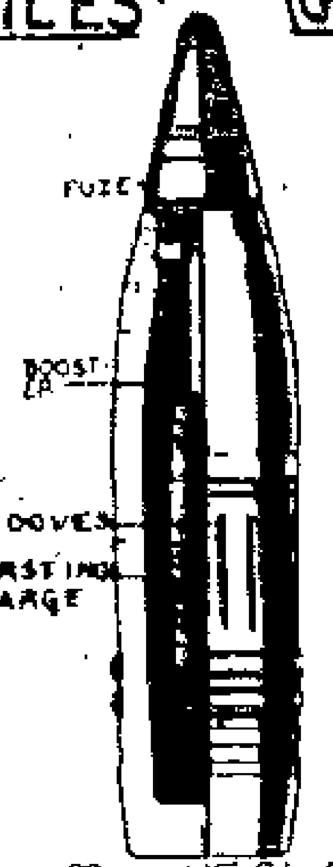
PROJECTILES (GRANATEN)



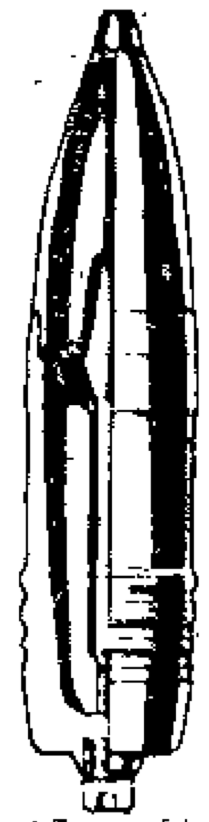
88 mm AP Shell Type 40



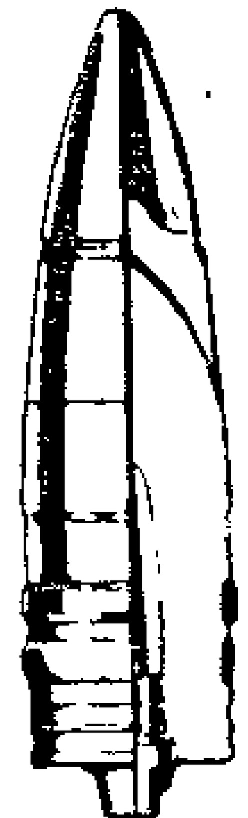
88 mm AP Shell 39/42



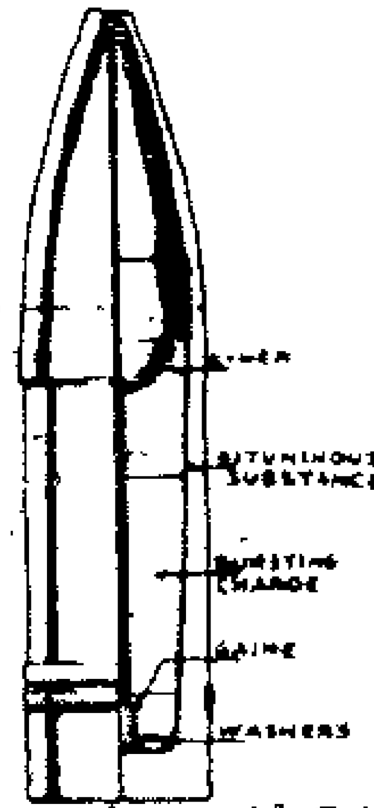
88mm HE Shell for AC Gun 41



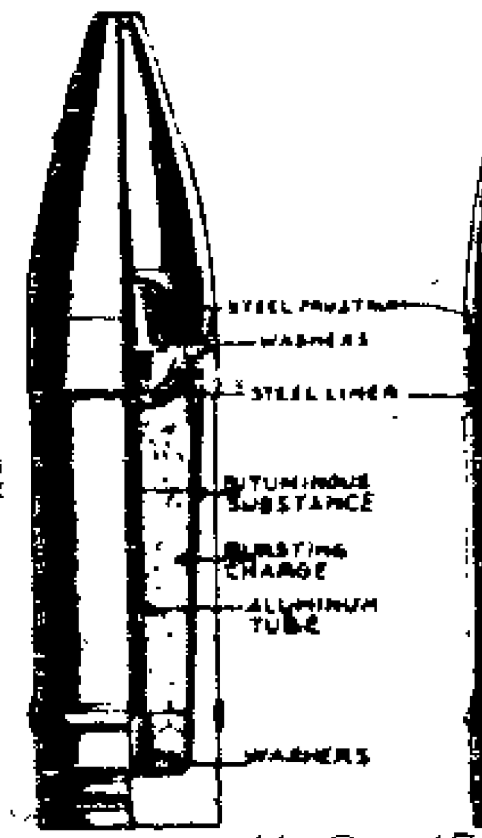
88 mm HoC Shell 39



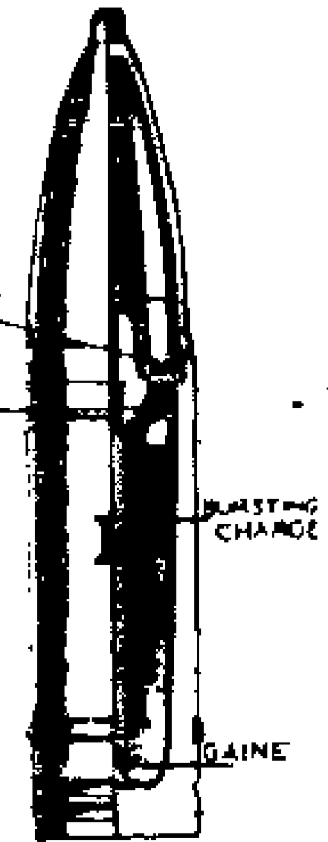
88 mm AP Shell 39/1



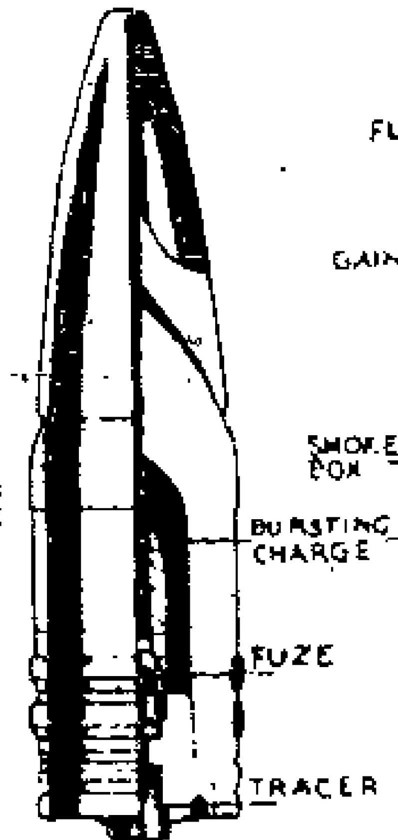
100 mm HoC Shell B 39 Rot



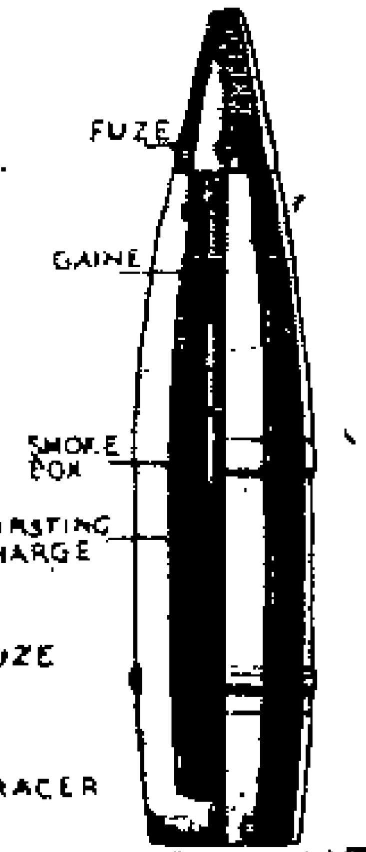
100 mm HoC Shell C 39 Rot



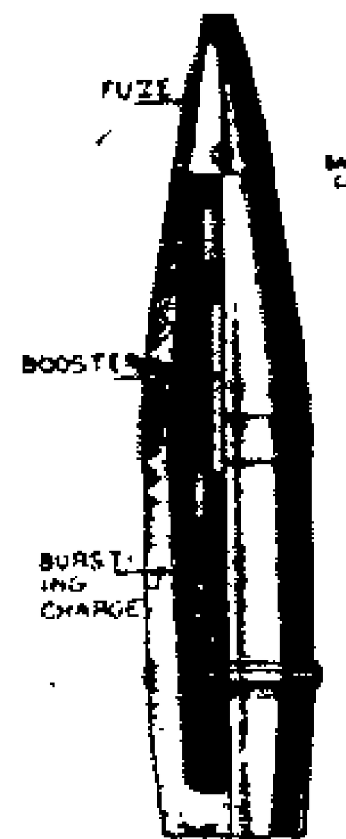
105mm HoC Shell C 39 FES



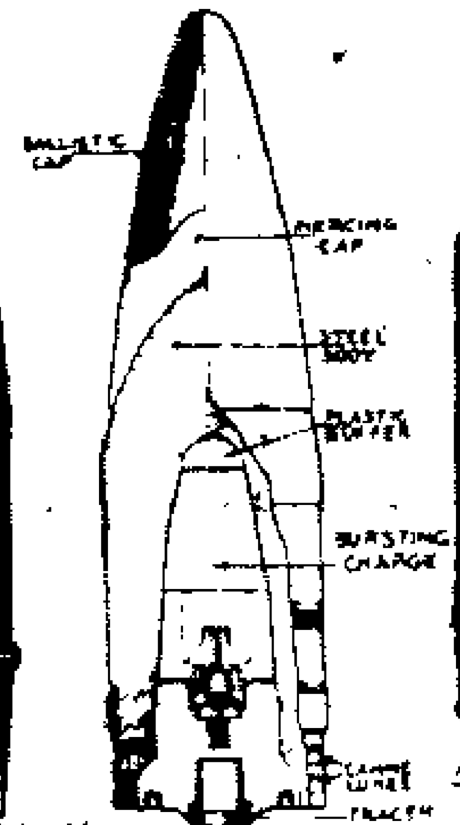
105 mm AP Shell Rot FES



105mm HE Shell 43(PG)

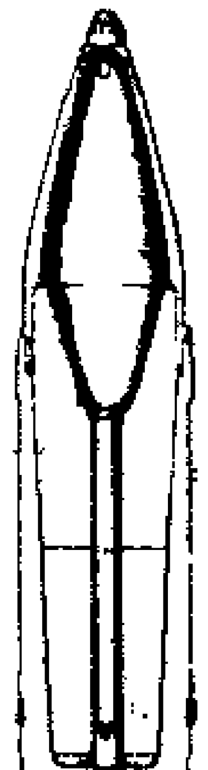


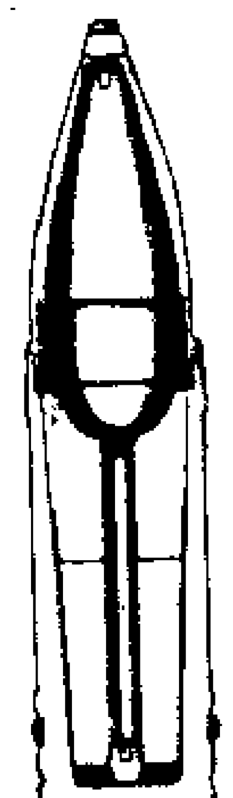
105mm HE Shell 38 Stg FES

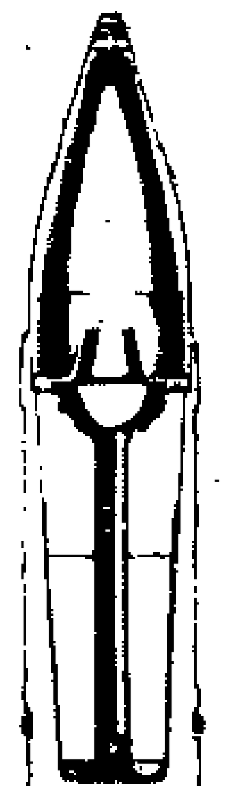


105mm AP Shell Rot

105mm HoC Shell 39 Rot







105 mm Hollow Charge Shells (39 Rot Hl/A) (39 Rot Hl/B) (39 Rot Hl/C)

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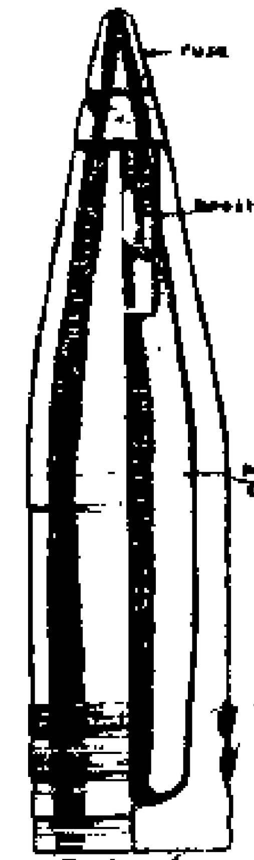
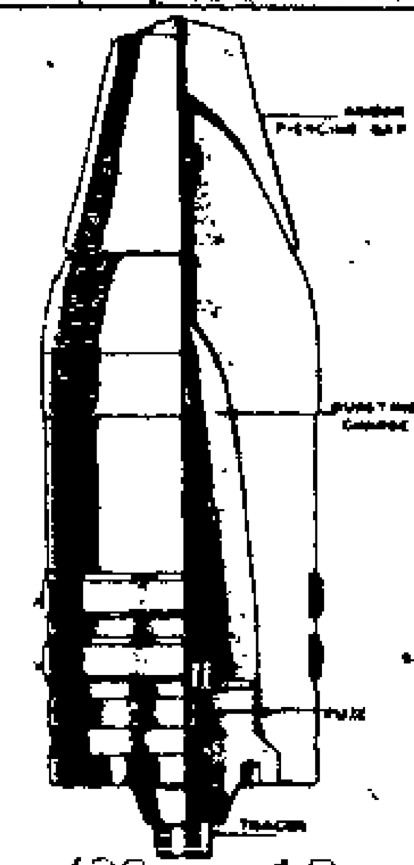
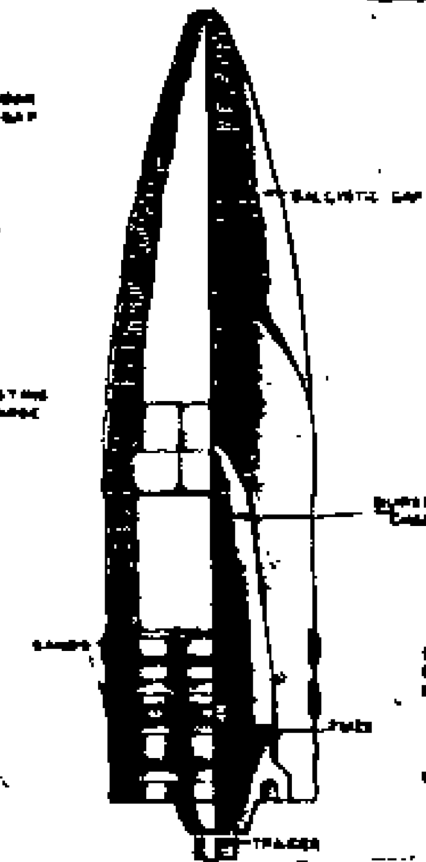
PROJECTILES (GRANATEN)



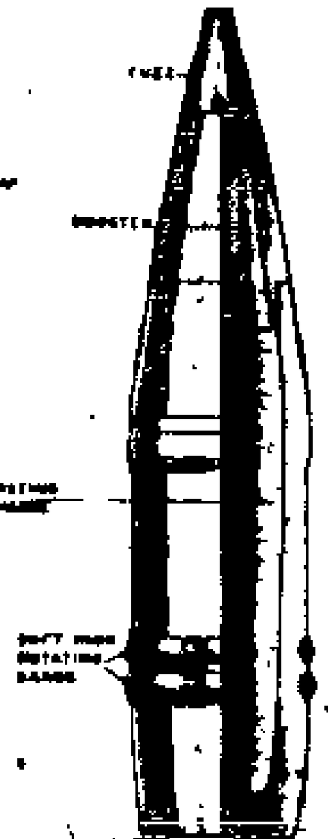
128 mm HE Shell L/4.5



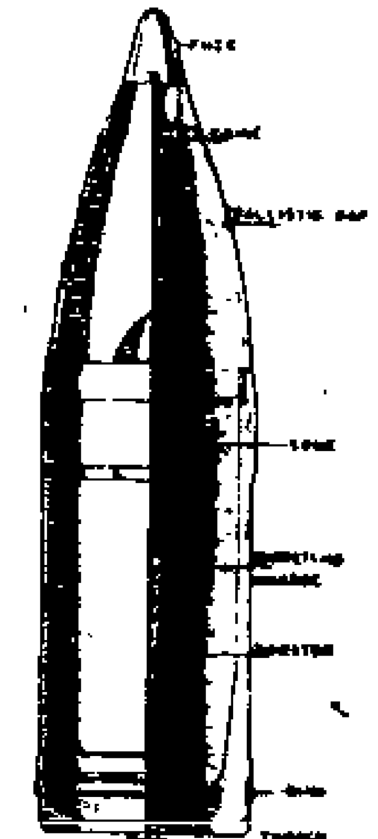
128 mm AP Shell (Pzgr KPS)



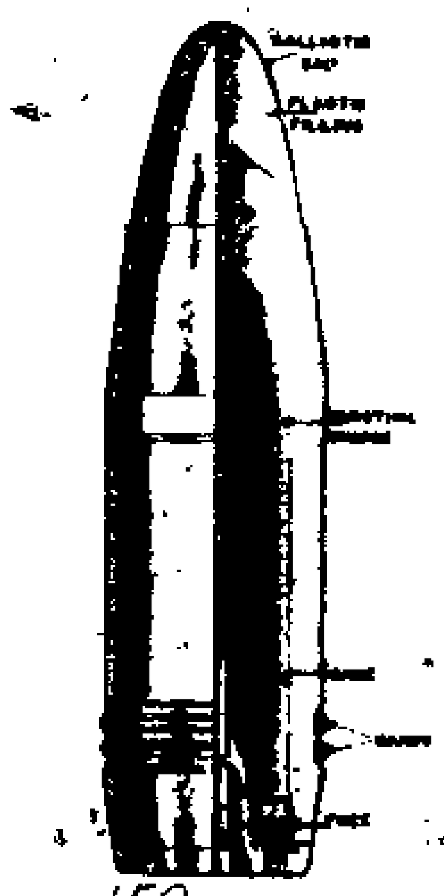
128 mm AP Shell (Pzgr 43)



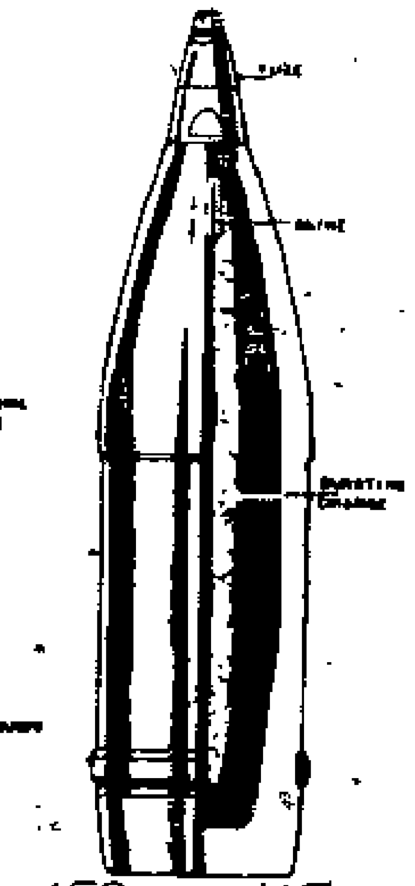
150 mm HE Shell (KGr 42)



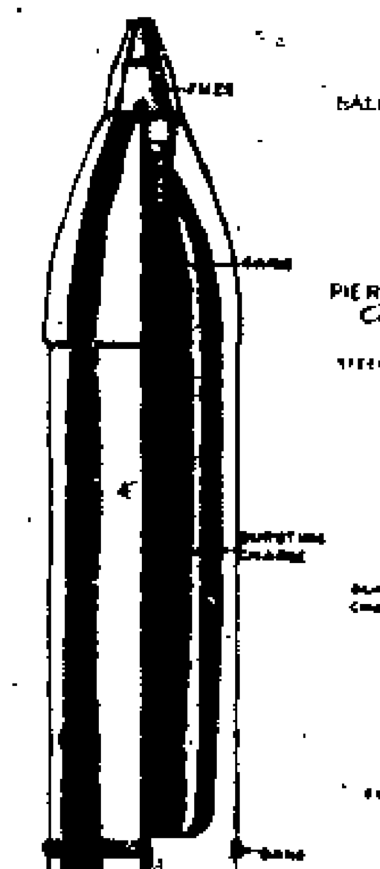
150 mm HoC/A Howitzer Shell (Jgr 39 Hl/A)



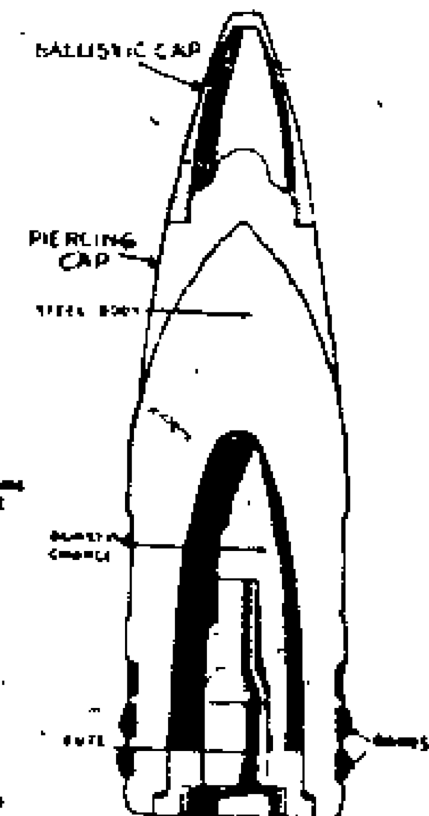
150 mm Anticoncrete Shell Type 19



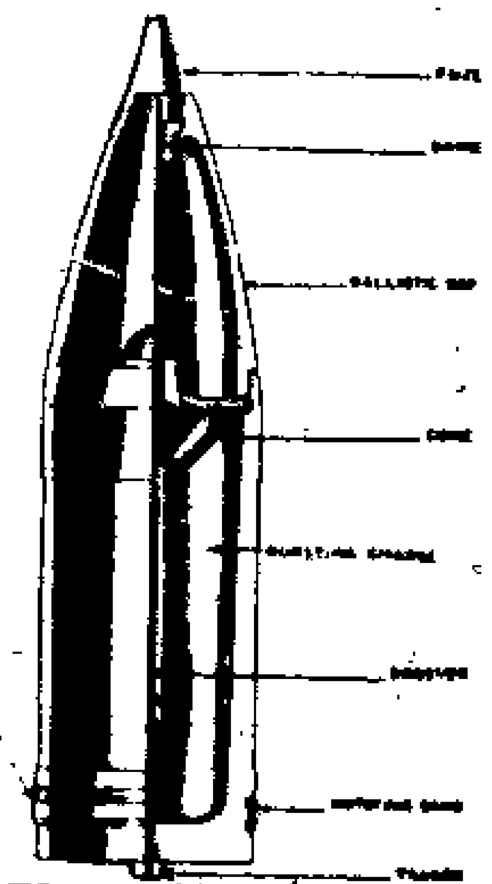
150 mm HE Howitzer Shell (Gr M34(f))



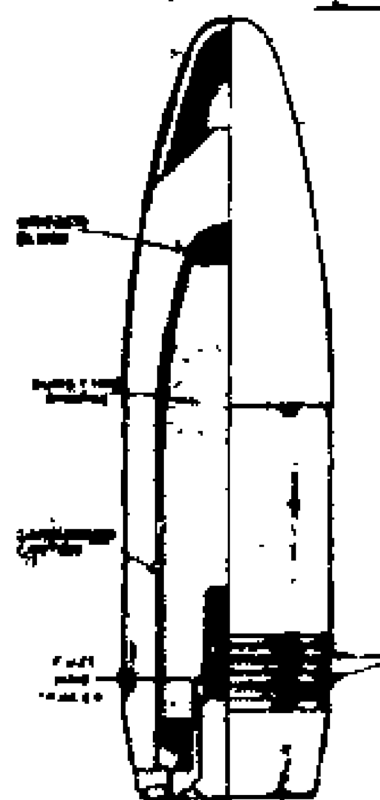
150 mm HE How Shell (Jgr 38 FES)



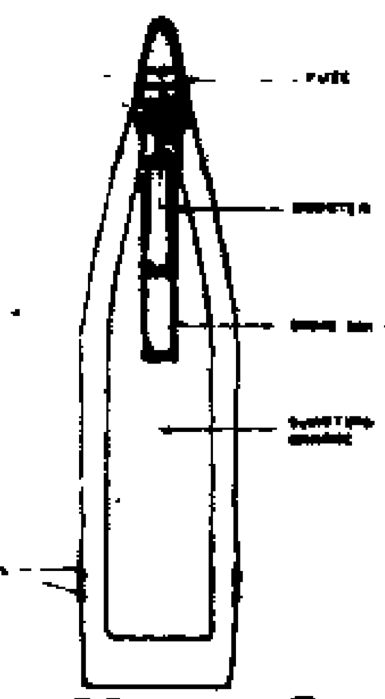
150 mm AP Shell for Heavy Gun 18



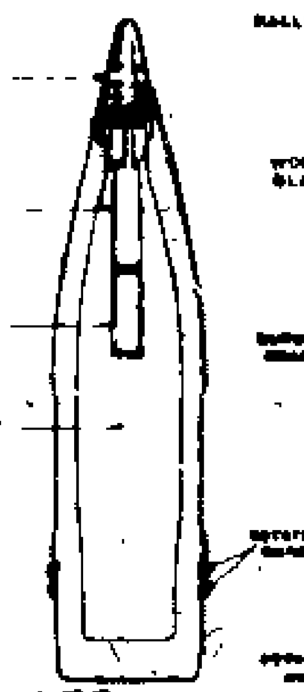
150 mm HoC/A Shell Type 39



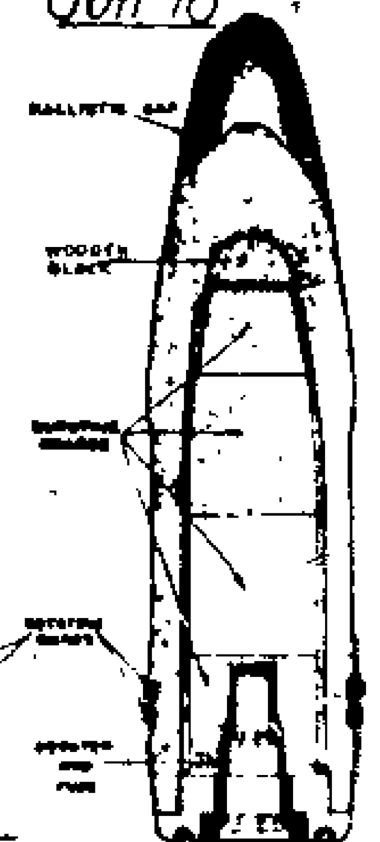
150 mm Anti-concrete Shell (Gr 19 Rot Be)



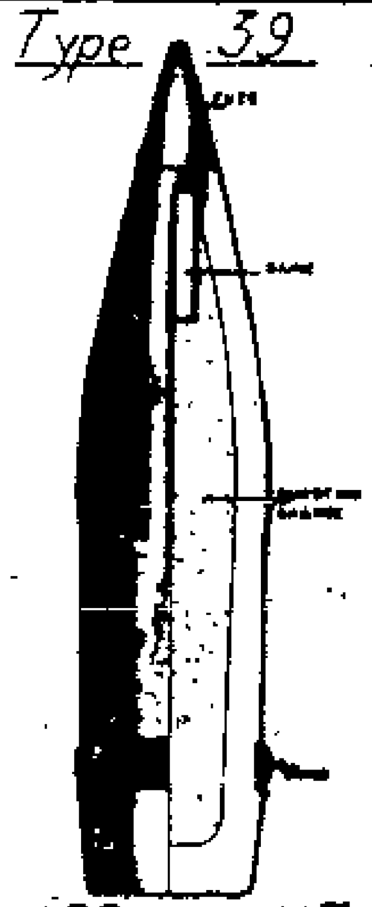
150 mm HE Shell Type 19 with Gaine 36



150 mm HE Shell (Cast Steel)



150 mm A/C Shell 19 Be



152 mm HE Shell FEW

o) Smoke (15 cm Jgr Nb) used in sIG 33 (p 497) (See also Smoke Projectiles)

p) Rodded Bomb (15 cm Stielgranate 42) used sIG 33 (p 498)

r) HE (15 cm Gr 18) used in sFH 13 (p 500); HE (15 cm Jgr 38) used in sIG 33; HE with Base Fuze and Ballistic Cap (15 cm Spgr L/4.4 BdZ mit Haube) used in Ki Mrs Laf (p 504); HE with Nose Fuze (15 cm Spgr L/4.6 Kz) used in K39 (p 504).

s) SAP (15 cm Hpzgr) used in K 39 (p 504)

t) AP (15 cm Pzgr) used in K 39 (p 504)

u) Smoke (15 cm Gr 38 Nb) used in sFH 18 (p 506)

v) A/C (15 cm Gr 19 Be) used in sFH 18 (p 507)

w) APC projectile for unknown weapon (p 509)

x) Rocket Assisted Projectile (15 cm RGr 19) (p 509)

21) **152 mm** included the following types used in captured Russian weapons:

a) HE (15.2 cm Spgr 436) used in KH 433/1 (r) and KH 433/2 (r) (p 510)

b) A/C (15.2 cm Gr 434 Be) used in the same weapons as above (p 511)

22) **155 mm** included the following projectiles used in captured French (f) and Polish (p) Weapons

a) HE [15.5 cm StgGr 422 (f)] used in K 418 (f), K 419 (f) and K 420 (f) (p 512)

b) Smoke [15.5 cm Gr 427 (f)] used in K420 (f) (p 512) (See also Smoke Projectiles)

c) HE [15.5 cm Gr 417 (f) and Langgr 415 (f)] used in sFH 414 (f) and sFH 17 (p) (p 513-4)

d) HE [15.5 cm Gr 421 (f)] used in 15.5 cm K 420 (f) (p 515)

23) **170 mm** included:

a) HE (17 cm KGr 38Hb) used in Ki Mrs Laf (p 516)

b) HE (17 cm KGr 39) used in Ki Mrs Laf (p 517)

24) **194 mm** included the HE proj [19.4 cm StgGr 486 (f)] used in captured French Railroad Gun, K(E) 486 (f) (p 517)

25) **200 mm** included the HE Mortar Projectile 20 cm Wgr 40 (p 534)

26) **203 mm** included:

a) A/C [20.3 cm Gr 503/2 Be (r)] used in captured Russian Heavy Howitzers H 503 (r) and H 503/2 (r) (p 519)

b) Flare projectile (20.3 cm Leuchtgr) used in K(E) (p 520) (See under Flares)

c) HE [20.3 cm Spgr L/14 Kz (Hb) and Spgr L/4.7 Kz mHb used in K(E) (p 521)]

d) SAP (20.3 cm Spgr L/4.7 BdZ mHb) used in K(E) (p 520)

27) **210 mm** included A/C proj (21 cm Gr 18 Be) used in Mrs 18 and in lg Mrs 18 (p 522)

28) **240 mm** included:

a) HE (24 cm Spgr L/4.5 BdZ mHb and Spgr L/4.2 mHb) used in Theodor Bruno Railway Gun, ThBrK(E) (p 524)

b) HE (24 cm Gr 40) used in Czech Heavy Gun, sK (t) (p 525)

29) **280 mm** included:

a) Rifled 28 cm projectile. Its nomenclature and uses are unknown (p 526)

b) HE Rocket Assisted Rifled proj (28 cm RGr 433 and Gr 35) used in K 5 (E) (p 527-28)

30) **355 mm** included A/C project (35 cm GrBe) for Howitzer M I (p 529) (Its caliber was also given as 353 mm).

31) **380 mm** included HE Mortar proj (38 cm Wgr 40) and Smoke proj (38 cm Wgr 40 Nb) (p 535).

American and British Abbreviations: AA Antiaircraft, AC Aircraft, A/C Anticoncrete; AP Armor-piercing; APC Armor-piercing, capped; **HE** High-explosive; **HoC** Hollow charge; Inc Incendiary; **SAP** Semi-armor-piercing; T Tracer

German Abreviations: See Abbreviations at the end of this German section.

Reference: Anon, Technical Manual TM 9-1985-3 (1953), pp 358-544

The same information is given in the following references:

1) **Anon**, Enemy War Materials Inventory List, Ammunition, Supreme Headquarters AEF, (1945), pp 1-154

2) **Anon**, Recognition Handbook of German Ammunition, Supreme Headquarters AEF (1945)

3) **Anon**, German Artillery Projectiles and Fuzes, Ordnance Bomb Disposal Center Aberdeen Proving Ground and U S Navy Bomb Disposal School, pp 1-177 (No date).

Note: According to Ref 1, pp 131-3, the following larger caliber projectiles were used by the Germans: 380 mm HE and AP for 38 cm **Siegfried Kanone C/34**; 406 mm HE and AP for 40.6 cm **Adolf Kanone** or for Navy gun, **Schiffskanone C/34**; 420 mm HE, Anticoncrete for 42 cm howitzer, called **Gamma Mörser**; 540 mm HE for 54 cm heavy howitzer, called **Karl Mörser**; 615 mm HE for 61.5 cm heavy howitzer, called **Karl Gerät** and 800 mm HE for 80 cm super heavy gun, called **Sevastopol** or **Gustav Geschütz**.

Granate Hand und Granate Gewehr (Hand Grenade and Rifle Grenade).

The following types of grenades are described in TM 9-1985-2 (1953), pp 319-345:

1) Stick Hand Grenades, Models 24, 39 and 43 (Stiehlhandgranaten 24, 39 und 43) (pp 319-20)

2) Egg Type Hand Grenade, Model 39 (Eierhandgranate 39) (p 321)

3) Shaving Stick Offensive Hand Grenade (p 322)

4) Magnetic Antitank Hand Grenade, 3kg (Hafthohlladunggranate, 3kg) (p 323) (**See Hafthohlladung**)

5) Hollow Charge Stick Type Hand Grenade (p 324)

6) Antitank (Hollow Charge) Hand Grenade (Panzerwurfmine) (p 324)

7) Smoke Hand Grenades, Models 39 and 41 (Nebelhandgranaten 39 und 41) (pp 325-6)

8) Smoke Hand Grenade 14 (Blendkörper 14) (p 327)

9) Smoke Hand Grenade 24 (Blendkörper 24) (p 328)

10) Smoke Hand Grenade, Egg Type (p 329)

11) Hand Smoke Signal, Red (Handrauchzeichen-Rot) (p 329)

12) Lacrymatory Hand Grenade (Tear Bomb) (p 330)

13) 46 mm Antitank (Hollow Charge) Rifle Grenade (S S Gewehrpanzergranate, 46 mm) (p 331)

14) 61 mm Antitank (Hollow Charge) Rifle Grenade (S.S. Gewehrpanzergranate, 61 mm) (Two types, pp 331 and 332).

15) Antipersonnel Rifle or Hand Grenade (Gewehr- oder Hand-Sprenggranate) (p 332)

16) Antitank (Hollow charge) Rifle Grenade (Gewehr Panzergranate) (p 334)

17) 37 mm Antitank (Hollow Charge) Stick Grenade (p 335)

18) Large Antitank (Hollow Charge) Rifle Grenade (Grosse Gewehr Panzergranate) (p 336)

19) Hollow Charge Rifle Grenade (Schuss GgP 40) (p 337)

20) Propaganda Rifle Grenade (Gewehr Propagandagranate) (p 338)

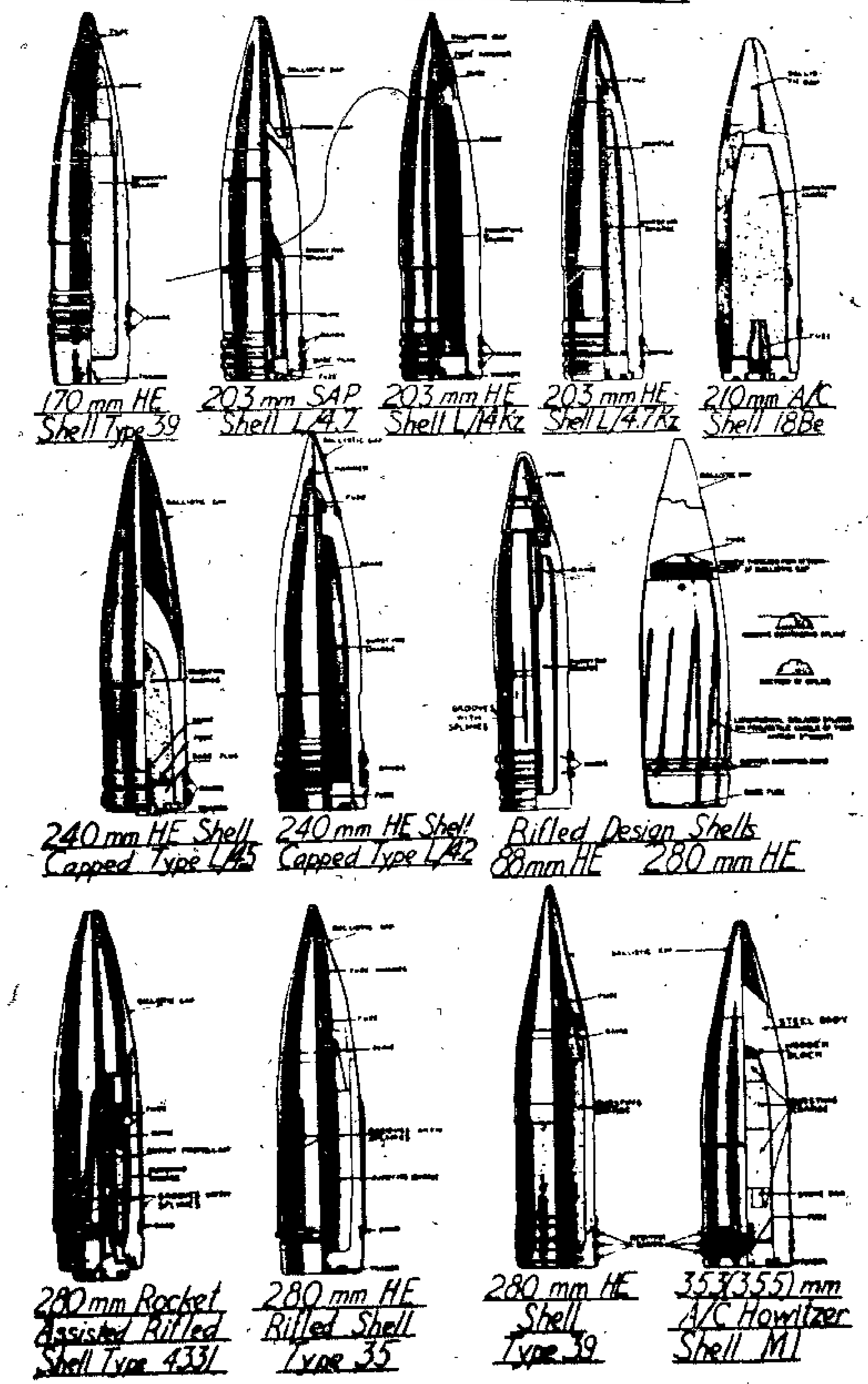
21) Illuminating Parachute Rifle Grenade (Gewehr Fallschirmleuchtgranate) (p 339)

22) Hollow Charge Grenade, called Faustpatrone (p 339)

23) Pistol Grenade (Wurfkörper Leuchtpistole) (p 340)

24) 27 mm Pistol Grenade HE Egg Type, fired from a Walther pistol (p 341)

PROJECTILES (GRANATEN)



170 mm HE Shell Type 39; 203 mm SAP Shell L/4.7; 203 mm HE Shell L/14Kz; 203 mm HE Shell L/4.7Kz; 210 mm A/C Shell 18Be

240 mm HE Shell Capped Type L/4.5; 240 mm HE Shell Capped Type L/4.2; Rifled Design Shells 88 mm HE, 280 mm HE

280 mm Rocket Assisted Rifled Shell Type 4331; 280 mm HE Rifled Shell Type 35; 280 mm HE Shell Type 39; 353(355) mm A/C Howitzer Shell M1

25) 26 mm Pistol Grenade (26 mm Wurfgranatepatrone für 326 Leuchtpistole) (p 342)
26) HE Cartridge for 27 mm Pistol Grenade (Sprengpatrone für Kampfpistole) (p 343)
27) Hollow Charge Signal Pistol Grenade (Panzerwurfkörper 42 Leuchtpistole) (p 344)
28) 27 mm Message Pistol Grenade (p 345)
29) 27 mm Multistar Signal Cartridge for Pistol (p 345)

Several of the German grenades were examined at Picatinny Arsenal, as shown by the following

References:
1) A.B.Schilling, Pic Arsn Tech Rept 1460 (1945) (Offensive Hand Grenade, Egg Type)
2) A.B.Schilling, ibid, 1467 (1945) (Hand Grenade, Stick Type)
3) A.B.Schilling, ibid, 1494 (1945) (Hand Grenade and Rifle Grenade for use in the Mauser Rifle Grenade Discharger)
4) F.G.Haverlak, ibid, 1507 (1945) (61 mm Rifle Grenade)
5) F.G.Haverlak, ibid, 1509 (1945) (46 mm Rifle Grenade).

Note: A brief description of pistol and rifle grenades is given under P and R.

Great Enzian or E-4. One of the guided (directed) missiles used by the Germans during WW II (See also Enzian, under Guided Missiles).
Reference: TM 9-1985-2 (1953), pp 229-30.

Granada. See Granate Hand und Granate Gewehr.

"Griess". An "atomized" aluminum powder consisting of small spherical particles. Its density was about twice as high as for Pyroschiff (q v). It was used in pyrotechnic compositions.
Reference: Dept of the Army TM 9-1985-2 (1953), p 82.

"Grizzly Bear". See Brumbär.

Groben Blättchenpulver. Large Grain Smokeless Propellant formerly used in larger caliber German guns is described in Daniel, Dictionnaire (1902), p 364.

Grundladung (Base Charge). This term applies to the base (main) charge of a blasting cap or a detonator or to a special ignition charge mentioned under Ignition. It does not, however, apply to the main charge of a propellant, which is called Hauptkartusche (See also under Cordite Charge Casings).

G-Salz is one of the names for Nitroguanidine, also called Nigu; it is abbreviated in this work as NGu.

Gudolpulver (Gudol Propellant), invented in 1937 by Dynamit A-G, may be considered as a G Pulver (DEGEN or TEGN propellant) in which a large amount of nitroguanidine (NGu) is incorporated.

As G Pulver is slow burning in comparison with NG propellants, it was found unsuitable for use in medium and small caliber mortars and howitzers. This is because the barrels of these weapons are too short to permit complete combustion of the G Pulver while the projectile is still in the gun barrel. In order to obtain satisfactory results in such weapons, the rate of combustion of the propellant should be higher than in the regular G Pulver but at the same time its flashlessness should be low. This can be achieved by incorporating into the G Pulver some nitroguanidine (NGu).

Due to the fact that ditrated glycols contained in G Pulver are good gelatinizers for NC, comparatively large amounts of NGu can be incorporated without making the propellant too brittle (NGu is not a gelatinizer for NC and is not gelatinized by nitrated glycols). In order to have a propellant of good performance, the crystals of NGu should be short and fine and uniformly distributed throughout the mass of the propellant. This was accomplished in the following manner:

After preparing the nitrocellulose - dinitrodiglycol (or dinitrotriglycol) jelly by kneading in a Werner-Pfleiderer apparatus, short fibered nitroguanidine was gradually added and thoroughly incorporated. Then the mass was rolled for about 25 minutes and the resulting sheets cut to the desired size.

Following is an example of a flake Gudolpulver suitable for howitzers: NC(N=13%) 38.03, DEGDN 31.12, NGu 30.00, acardite 0.50, MgO 0.25 and graphite 0.10%.

Nitroguanidine was also found to be suitable for incorporation in cool tubular cannon propellants, as for instance: NC(N=12%) 39.48, DEGDN 16.92, NGu 30.00, ethylphenylurethane 5.00, diphenylurethane 4.25, K nitrate 4.00, MgO 0.25 and graphite 0.10%.

Other formulations of NGu propellants are given under Propellants.

Among the advantages of NGu propellants may be cited: low erosion of gun barrels and practically complete absence of smoke and muzzle and breech flash. This was achieved without addition of any flash reducing agents such as K_2SO_4.

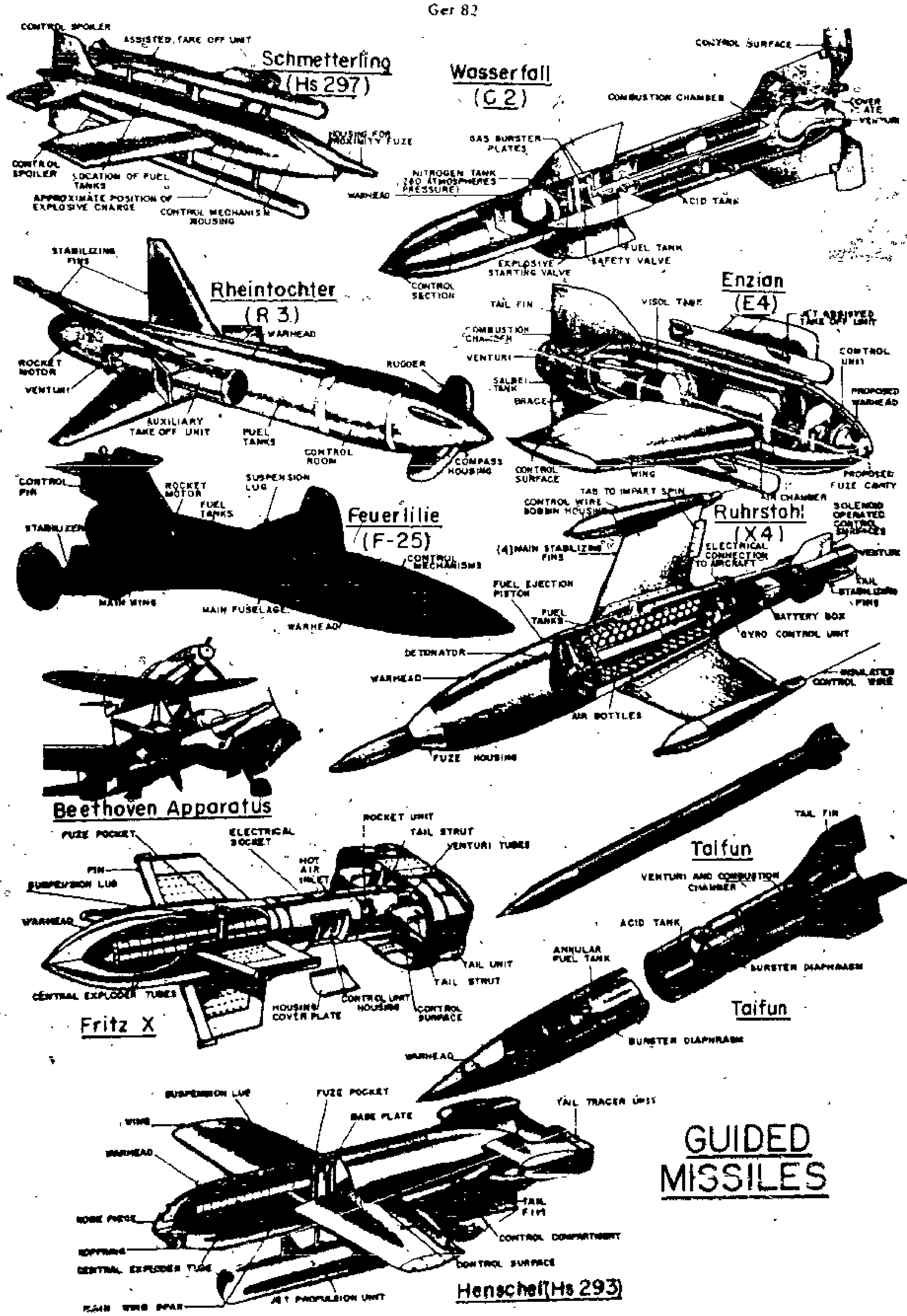
With the introduction of rapid-fire weapons, such as AA guns or those used on armored vehicles, the problem of breech flash became of utmost importance because the breech has to be opened immediately after each firing and less time is given for cooling the chamber gases than in the case of slow-firing weapons. It should be noted that modern rapid-fire weapons are provided with semi-automatic breech closures and muzzle brakes. The brakes tend to retain the gases back in the barrel and when the breech is opened, the gases emerge in a glowing condition, endangering the lives of the personnel and are capable of igniting any combustible or explosive substance in the vicinity. With Gudol propellant this breech flash was practically eliminated. (See also "Flash Reductants in German Propellants").

References:
1) U.Gallwitz, Die Geschützladung (Propelling Charge), Heereswaffenamt, Berlin (1944)
2) O.W.Stickland et al, General Summary of Explosive Plants, PB Rept 925 (1945), Appendix 8.

Guhrdynamit. See the Swedish Section.

Guhrhellhofit. An explosive prepared about 1880 by mixing Kieselguhr with nitrobenzene and fuming nitric acid [Colver (1918) p 143].

Guidance Systems for Missiles. The principal German devices for guiding space-traversing unmanned missiles which carried within themselves the means for controlling their flight paths, are listed below and in some cases briefly described in References 1, 2 & 3. The systems may be subdivided into the following groups:



A. **Acoustic Homing Devices.** These utilized the sound produced by airplane engines as a guiding medium. Two such devices were developed and were intended for guiding the X-4 missile. Both systems received the sounds from two separate entrance ports and determined the direction of the target by comparing the phase of the incident sound front. Phase comparison circuits were used to command the missile to maneuver so that the phase angles became equal. This made the missile point directly at the target. The principal advantage of the acoustic homing missile was the impossibility of jamming its receivers (such as is done with radio controlled guidance systems (Ref 3, pp 602-5)

Note: According to Ref 2, pp 216-19 & 229, the original acoustic homing system was called Kranich and the later version Pudel. The Pudel acoustic proximity fuze consisted essentially of a mica and 0.03 mm aluminum foil diaphragm connected to a carbon microphone the output of which was fed to a single stage amplifier and relay output. The assembly was mounted at an angle of about 60° to the axis of the body and the sound passed into the diaphragm through a series of wire mesh screens which served to attenuate differences of air pressure due to rotation but not the sound of motors and propellers of enemy aircraft. A small lyre arrangement was attached to the vibrating system in such a way as to broaden the mechanical resonance curves of the individual components of the system. If the missile, such as an X-4, was homing directly on the target, the output of the microphone was constant and as there was no modulation output no steering corrections were necessary. If the missile was not aimed directly at the target, there was generated a modulation frequency of 1½ cycles per second, the rotation speed of the missile. This modulation frequency transmitted the information to the spoiler solenoids in the tail fins, through the gyro commutator system. This arrangement converted the left-right and up-down signals into the proper pulses which were to be fed to the solenoids actuating the spoilers. The range of this device was expected to be about 1000 meters, so that if it were launched at a range of 2000 m, the first 1000 m of its flight would be uncontrolled. The Pudel fuze was not sufficiently developed to be used in combat, but the Kranich fuze was. The Kranich consisted of a light diaphragm-actuated mechanism which responded to the sound of airplane propellers at a range of 15 meters. It was constructed on the same principle as the Pudel fuze. It was planned to install the Kranich system on some Rheintochter missiles

B. **Ballistic Guidance System,** also called **Inertial-Gravitation Guidance System.** This was essentially similar to a long-range gunfire guidance. As with a gun for surface fire, a missile such as a V-2 (A-4), was aimed in the desired direction in azimuth and pointed at such a precalculated elevation angle that the projectile would fall to the surface at the correct target range. The V-2 was directed in heading during its burning period by four external and four internal vanes. The external vanes, located in the outer trailing edge of each large fin, created aerodynamic moments, whereas the internal vanes, made of carbon and located to to the rear of the motor, varied the direction of thrust of the motor. For control in azimuth, the external and internal vanes were interlocked but they were so connected as to permit separate control in pitch. (Ref 3, pp 36-8 & 583-4).

According to Ref 2, p 211, the V-2 missile was regulated in flight by fins which were positioned by hydraulic servo-mechanisms controlled by an elaborate intelligence system. This system consisted of:

a) Two gyroscopes to provide stability about the three axes of the missile

b) Radio (optional) to provide azimuth control by flying on a beam

c) Radio or integrating accelerometer for turning the motor at a specific velocity, to provide range control

d) Time switch control to bend the missile over toward the target after it was launched vertically.

After elaborate preparations requiring much time, personnel and equipment, the V-2 was fired vertically from a metallic launcher. A few seconds after the V-2 was in the air, the time switch control caused the missile to bend gradually over in the direction of the target. After 1 minute of flight, the motor was turned off leaving the missile at about a 45° angle and having a velocity of about 3,400 mph. For the remainder of the flight, the V-2 followed the trajectory of a free body in space reaching a maximum height of about 50 miles before returning to the surface of the earth. About 5 minutes after take-off, the V-2 struck the earth some 200 miles from the launching site with a velocity of approximately 1,800 mph causing the warhead and any remaining fuel to explode

C. **Infrared (IR) Guidance System** consisted essentially of a concave mirror directed toward a target emitting the infrared radiation. A rotating disc and a photocell connected by a wire to a mechanism regulated the right-left and up-down movements of the missile. A schematic view of such device is given on p 11 of Ref 1 and a general description on detection of the infrared is given in Chapter 5 of Ref 3. One of the IR homing devices was used on the Rheintochter, R-3 (Ref 2, p 229), while another IR device, called Madrid, was installed on the Enzian, E-4 missile (Ref 2, p 232)

D. **Magnetic-Ballistic Guidance System,** such as used in the V-1 (FZG-76) missile, called also a "Buzz Bomb", was simple, rugged and reasonably reliable. In this system the azimuth was controlled by a magnetic compass, the altitude by a barometric altimeter and the range by an air mileage measuring unit. Prior to launching the missile, the devices were manually set for the desired course, altitude and range. The compass was linked to the directional gyroscope, whereas the altimeter acted directly on the elevator control system. All of the controls and amplifiers were pneumatic and the high-pressure air was stored in two tanks. When the predetermined range was reached in flight, the warhead was actuated and armed. The controls were then locked causing the missile to dive. The accuracy of the terminal portion of the flight depended upon the ballistics of the missile. (Ref 3, pp 35-36, 327-8 & 335-7). For more information on guidance systems for V-1 see Ref 2, pp 207-9. Some V-1 bombs were equipped with a one-tube radio transmitter for enabling the launching crew to follow the flights with direction finding equipment in order to obtain plotting and wind data (Ref 2, p 209)

E. **Radar Guidance System or Radio Detection and Guidance System** was not sufficiently developed to be used on a wide scale. Radar tracking of the target was used for guiding the Wasserfall and Rheintochter missiles. (Ref 2, p 227 and Ref 3, p 41)

F. **Radio Controlled Guidance Systems** consisted essentially of a radio receiver (located in a missile), a missile tracker and a radio transmitter (located near a missile launcher) for conveying the command to the receiver. This system was used in the majority of German guided missiles including the PC 1400 RX Glider Bomb (Ref 2, pp 195-6), Hs 117, called also Schmetterling (Ref 2, p 196 & 199), Hs 293 A-1 (Ref 2, pp 201 & 203), Hs 298 (Ref 2, p 204), some V-1 missiles (Ref 2, p 207), some V-2 missiles (Ref 2, p 211), Wasserfall C-2 (Ref 2, pp 219-23), Feuerlilie F-55 (Ref 2, p 226), some Rheintochters (Ref 2, p 227), Great Enzian (Ref 2, p 232) and some others.

Note: Hs 293A was the first German radio controlled bomb. It was made in 1940 by Henschel, by equipping with radio control devices, the non-guided glide bomb designed in 1939 by the Gustav Schwartz Propellerwerke (Ref 2 p 202)

The following German radio controlled systems are listed or briefly described in Refs 2 and 3:

a) **Burgund** system consisted of an optical (visual) missile tracker, **Knüppel,** with a joy stick control, a radio receiver **Strassburg** and a transmitter, **Kehl.** The Strassburg-Kehl combination was used in the PX-1400 glider bomb, Schmetterling (Hs 117) rocket, Wasserfall (C-2) rocket and Great Enzian rocket (Ref 2, pp 215-16, 223 & 232 and Ref 3, pp 38-43)

Note: As a substitute for the Strassburg-Kehl command link, the **Kran-Brigg** system was developed late in WW II (Ref 3, p 41)

b) **Elsass** system was similar in operation to the Burgund's, except that radar tracking of the target replaced the optical tracking. It was proposed for use with the Rheintochter 3 and some other missiles (Ref 2, p 227 and Ref 3, p 41)

c) **Sonne** radial guidance system was based on the method which a navigator of a ship uses to determine its position by plotting the reverse bearings obtained from the radio transmitters of two known locations. The device Sonne was more complicated than the systems used in ship navigation. A brief description of the principles applied in the Sonne is given in Ref 3, p 595

d) **Friesicke & Höpfner** radio receiver, first mounted on a Hs 293 missile proved to be too heavy and complicated for use. It was replaced by the **Stern** radio receiver (Ref 2, p 199)

e) **Stuttgart** radio telemetering system was tested on the Feuerlilie F-55 missile (Ref 2, p 226)

f) **Strassfurt** radio control system designed by the Rundfunk Co was planned to be used in the Enzian missiles (Ref 2, p 232)

g) **Kögge** radio control system designed by the Telefunken Co, was intended for use in Enzian missiles (Ref 2, p 232)

G. **Wire Controlled Guidance Systems.** Owing to the fact that radio command guidance systems were susceptible to electronic countermeasures (jamming), a control by wires was developed. The system was installed in the X-4 air-to-air missile and was planned to be installed on the X-7 surface-to-air missile and some Henschel missiles (Ref 2, pp 205 & 216-17 and Ref 3, p 41). The wire links system was effective over short distances without fear of enemy countermeasures.

According to Ref 2, p 217, the wire controlled system used in the X-4 missile consisted essentially of a small optical joy-stick control target tracker mounted in the aircraft, a pair of control wires and a receiving unit in the missile consisting of a gyroscope and a pair of relays. The control unit in the plane contained two revolving drums, one of them controlling azimuth and the other elevation. The control wires consisted of two insulated single strand Swedish spring-steel wires 6000 m in length and 0.22 mm in diameter. The receiving unit in the missile consisted of a polarized relay for azimuth control and an unpolarized marginal relay for elevation control. The first relay responded only to polarity changes in the direction of current flow through the wires, while the marginal relay responded only to changes in the value of the current regardless of its polarity. In this way, both azimuth and elevation control signals were transmitted simultaneously over the same pair of wires. The relays were connected to the spoiler solenoids in the tail fins, through the gyro commutator system. This arrangement converted the left-right and up-down signals into the proper pulses which were fed to the solenoids actuating the spoilers. The power supply consisted of a small 9-volt dry battery located in the afterbody of the missile.

Note: The mechanical difficulties encountered in earlier models were solved by paying out the wire from the spools on the missile and similar spools on the parent plane simultaneously (such as the Me 262 fighter plane).

According to the description given in Ref 3, pp 41-2, the launching and guiding of the X-4 missile were conducted as follows:

1) The missile was aimed and launched from the parent airplane

2) Simultaneously with this, sections of wire were ejected by means of black powder charges located in the wire spools, one in the airplane, another in the missile. The length of insulated steel wire in each spool was 12 km and there were two additional reels containing 18 km of wire located on opposite wing tips of the X-4

3) Immediately after launching the X-4, the gyroscopic autopilot (located in the missile) was put into operation, the warhead became armed for ready detonation and flares (located on the wing tips of the X-4) were ignited

4) As the X-4 proceeded on its flight, the wires continued to pay out from both the airplane and the missile spools and thus the missile was continuously guided by command along the optical line of sight between the pilot and the target

5) The X-4 missile rotated about its longitudinal axis 60 rpm and because of this rotation, there was a cancellation of aerodynamic misalignments resulting from production tolerances. This simplified the stabilization problem and a single gyro was sufficient to properly orient the pitch and yaw signals as the missile revolved

6) To prevent the inductance of the wire on the spool from distorting the command signals, one centimeter of insulation of each turn of wire was removed in order to create a short for the whole reel

Note: Since the above method of control restricted the maneuverability of launching planes and required that they remain in the vicinity of missiles, thus exposing themselves to the weapons of enemy's bombers, the wire control method was replaced in the latter model of the X-4 by an acoustic homing device called Kranich. With the latter device the parent plane could execute an evasive maneuver the moment the missile was launched and to withdraw itself beyond the range of enemy bombers weapons. (Ref 2, p 216),

The following varieties of wire command links systems are briefly described in Ref 3, pp 41-2:

a) **Dortmund-Duisburg** system consisted of an optical joy-stick control unit, a transmitting unit, two spools with wires (as described above) and a receiver located in the fuselage of X-4. The transmitting equipment consisted of an oscillator (operated by pulses from the joy-stick control) and an audio power amplifier which transmitted two audio-frequency signals through wires to the receiving set in the missile. The audio signals were demodulated by the receiver to operate two polarized relays, one for pitch and another for yaw control;

b) **Doren-Detmold** wire command link was a simple direct-current device which employed no vacuum tubes. The signals were transmitted to the receiver, which consisted of three relays. The 1st relay was sensitive to the polarity of the direct current signals (pitch control), the 2nd relay was sensitive to the amplitude of the signal (yaw control) and the 3rd served to disconnect the other two when the transmitting wires were broken. In this case, the missile continued to follow the course of the last command received. The wires were the same as with the Dortmund-Duisburg system except that insulation was not removed, since it was essential in this system to keep the resistance of wires constant.

Note: In all wire control systems, the fall of wire to the earth proved to be a nuisance and a hazard.

References:

1) L.E.Simon, German Research in World War II, J.Wiley, N Y (1947)

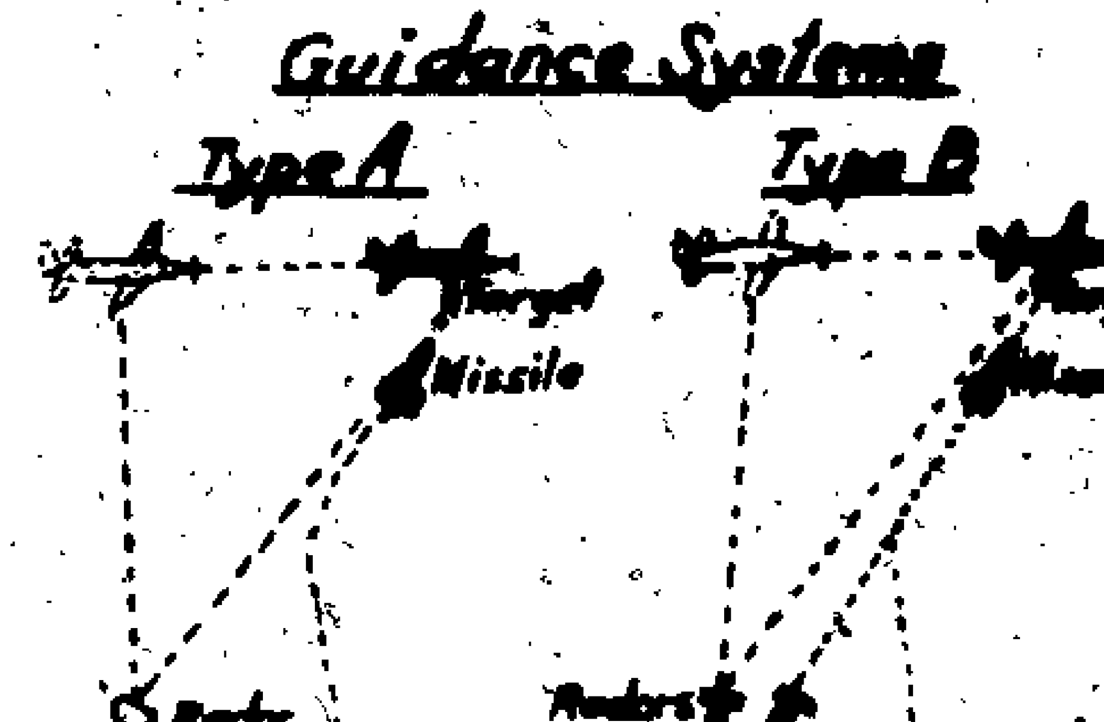
2) Anon, German Explosive Ordnance, Dept of the Army Technical Manual, TM 9-1985-2 (1953), Washington, D C

3) A.S.Locke, et al, Guidance, Van Nostrand, N Y (1955) (Vol 1 of series edited by G.Merrill and entitled: Principles of Guided Missile Design).

Note: According to the K.W.Gatland's book, "Development of the Guided Missile", "Flight" Publication, London (1952), pp 13-16, the current European and American guidance systems may be subdivided into:

A. **Beam Rider Control System.** With this system a ground radar tracks the target (such as an airplane), while the attacking missile climbs within the cone of a radar beam towards the target. The system is usually considered in conjunction with a self-homing device which monitors the gyropilot of missile so that in the final stage of an attack the missile is self-directing. This system is not as good as the:

B. **Command Guidance System.** With this system one radar tracks the target, while the other tracks the missile. Each radar feeds data into a computer, whereby steering commands are transmitted to the missile.



Guided Missile (Gesteuerte Geschoss). Beginning about 1938 several successful guided missiles were developed at Peenemünde, Volkenrode, etc. One of the first German guided missiles was the Rheinbote (Rhein Messenger) (Ref 2, p 34).

Other successful guided missiles were:

a) Schmetterling (Butterfly), also known as the Hs-117 (Ref 2, p 35)

Note: Hs is an abbreviation for Henschel, the name of the builder

b) Wasserfall (Waterfall) (Ref 2, p 37)

c) Rheintochter (Daughter of the Rhein; series such as Rheintochter I, II and III (Ref 2, p 40)

d) Enzian (Gentian, a species of blue flower) series, ranging from E-1 to E-5 (Ref 2, p 43 Ref 3, p 99)

e) Feuerlilie (Fire Lilly) series, of which the Hecht (pike) was one of the first successful. T-Stoff and Z-Stoff were used in it. The Hecht was succeeded by the Feuerlilie F-25. The last of the series was the F-55, used only for research (Ref 2, pp 45-47, Ref 3, pp 95-6)

f) Bächem BP-20 Natter (Viper) (Ref 2, p 47)

g) Ruhrstahl (Steel of the Ruhr) series ran from X-1 to X-7, of which the X-4 was the most important (Ref 2, p 50 and Ref 3, pp 90-2)

h) Hs (Henschel, the name of builder) series, including the previously mentioned Hs-117 (Schmetterling), as well as Hs-117H, Hs-293, Hs-294, Hs-295, Hs-296 and Hs-298 (Ref 2, pp 52-54 & 56-60, Ref 3, pp 92-3)

i) Fritz X (FX-1400), a glide bomb (Ref 2, p 55)

j) Beethoven Apparatus – an odd-looking guided missile (Ref 2, pp 61-62)

k) BV-246 (Ref 2, p 63)

l) V-2, is briefly described separately under V-2. It could be launched as a guided missile

m) Antipodal Bomber (Ref 4, pp 57-58)

n) Tolfun, a biliquid rocket (Ref 5, p 223).

References:

1) Anon, Army Ordnance 31, pp 28-30 & 121-24 (1946)

2) F.Ross, Jr, Guided Missiles, Rockets and Torpedoes, Lothrop, Lee & Shepard Co, Inc, N Y (1951), pp 14-66

3) A.Ducrocq, Les Armes Secrètes Allemandes, Berger-Levrault, Paris (1947) pp 90-99

4) K.W.Gatland, Development of the Guided Missile, "Flight" Publication, London (1952), pp 2-19, 47 & 49-59

5) Anon, Dept of the Army Technical Manual TM 9-1985-2 (1953), pp 195-233

Note: Additional information on guided missiles, also called Directed Missiles may be found in the following CIOS Reports: 28-56, 29-45, 31-13 and 32-66, which were published in 1945 and 1946

(See also Great Enzian Guided Missile, Rockets and V-2).

Gummidynamit. A rubberlike elastic explosive mass obtained on dissolving collodion cotton in NG. This is called also Sprenggelatine (Blasting gelatin).

Gun (Geschütz). See Kanone and also Weapons.

Guncotton-Dynamit. See Trauzl Dynamit.

H. One of the abbreviations for Hexogen or Hexo (Cyclonite).

H_5, H_{10} etc. Hexogen phlegmatized with 5%, 10% etc Montan wax.

H-1, H-2, H-5, H-8 Explosives. German Ammonites, described under Ersatzsprengstoffe.

HA. One of the abbreviations for mixture of RDX (Hexogen) and Al (aluminum).

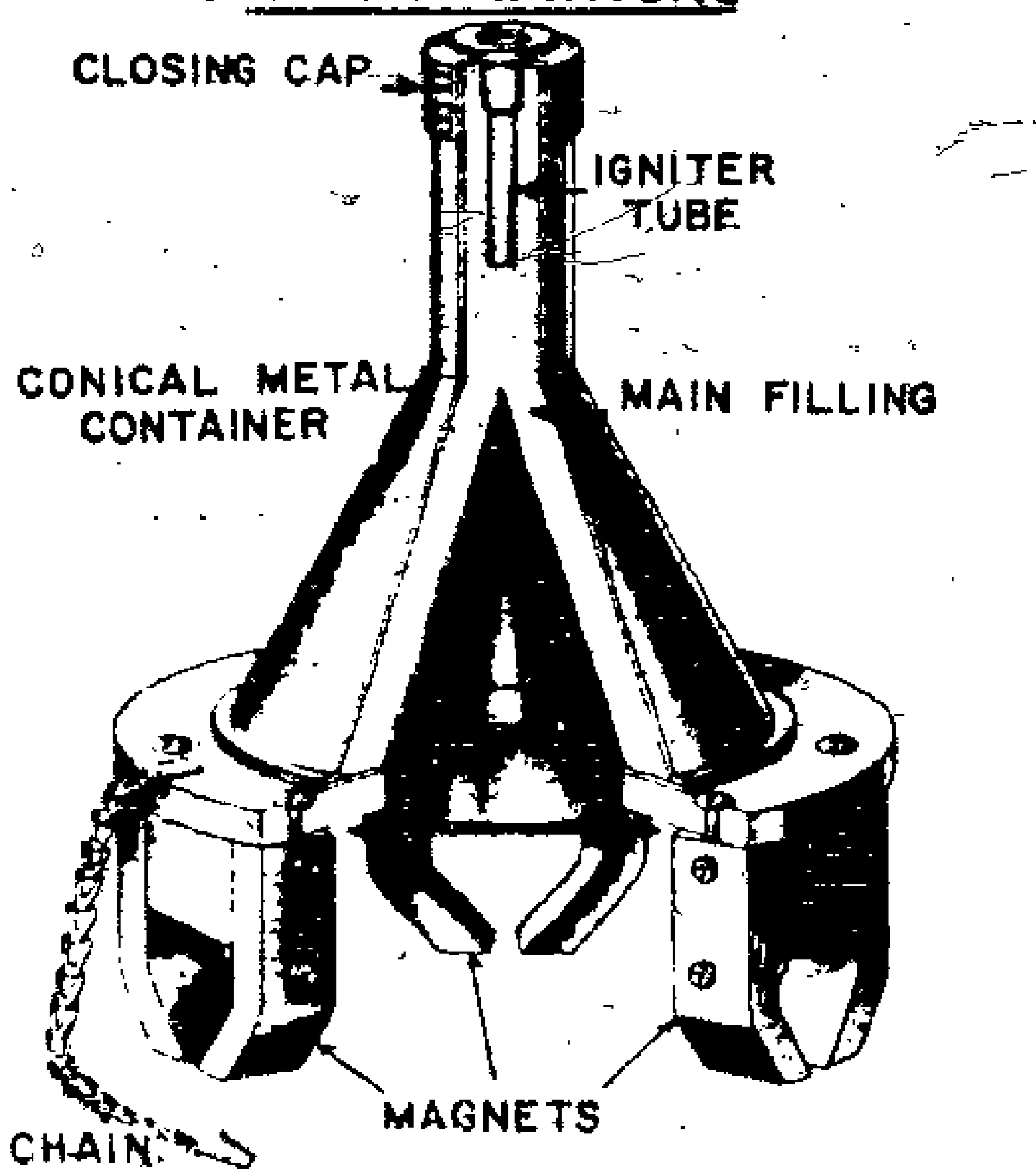
Hafthohlladung (Adhering or Sticking Hollow Charge). One of the devices consisted of a conical metallic container (filled with 3 lb 5 oz of a HE) to which was attached an elongated apex, serving as a hand grip and contg the exploder pellet (PETN/Wax) and a pull (friction) delay igniter (4½ or 7 seconds). Attached to the base of the conical section was a plywood frame-work carrying three powerful horseshoe magnets. A brass chain with a hook was attached to the framework. Total weight 3 kg.

The device could be used either as a hand grenade or as a land mine. In the first case the cord of the friction igniter was pulled off and the grenade thrown against the approaching vehicle. In the second case, the device was buried in the ground, close to the surface, with the magnets up and with the igniter cord attached to the ground. At the approach of a vehicle the magnetic attraction caused the grenade to jump towards some iron or steel part and attach itself to it. Simultaneously the cord was pulled, thus setting off the explosive train consisting of delay igniter, exploder and main charge, (Ref 2). It was claimed that this charge could penetrate as much as 110 mm of armor. (Ref 1, pp 323-4).

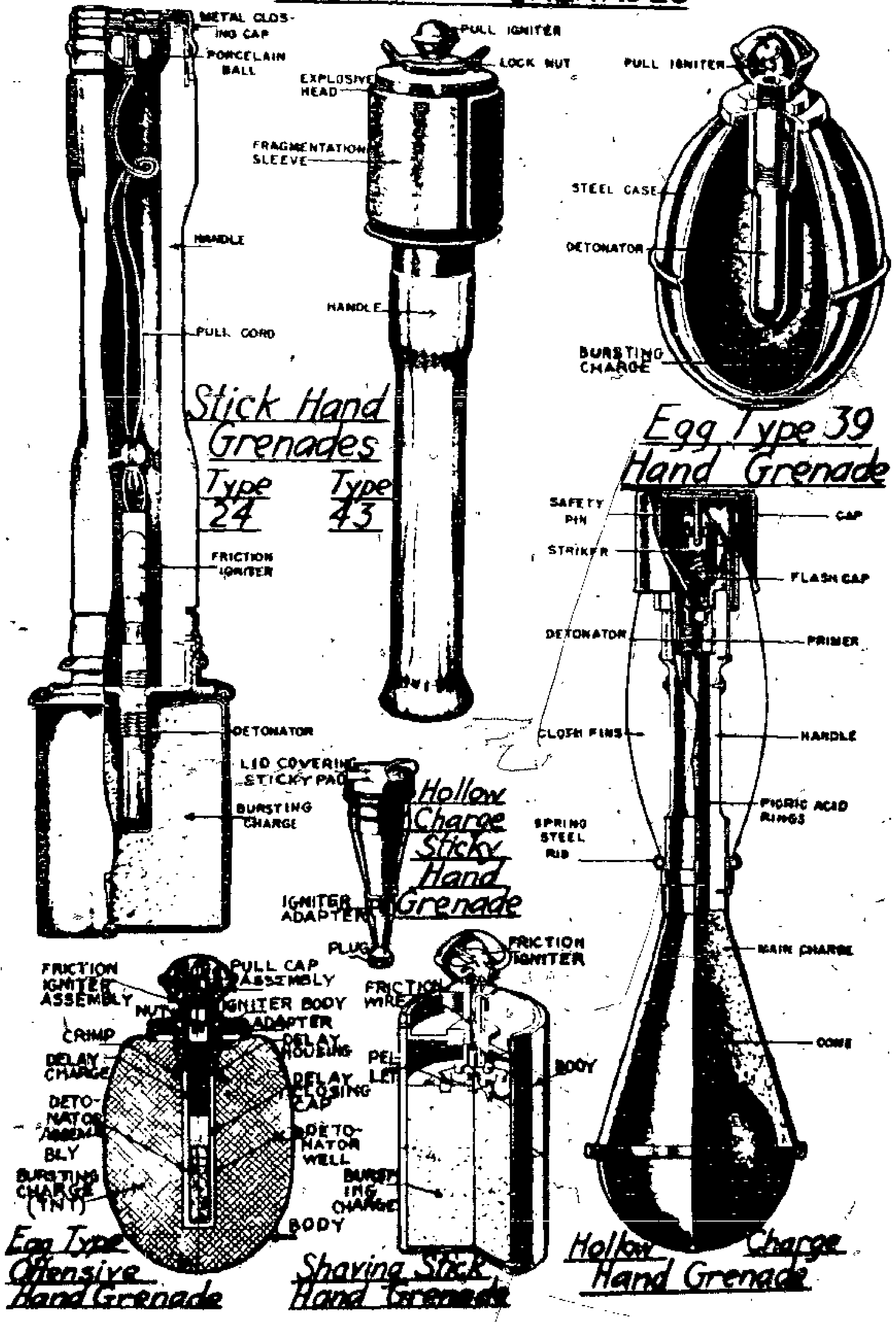
Another magnetic antitank charge is described in Ref 1, pp 262-3 under the name of **Panzerhandmine 3.** It consisted of a bottle-shaped cardboard container with 2 1/3 lb of hollow charge (TNT or RDX/TNT). Three pairs of magnets were mounted at the bottom of the bottle, and a 7½ sec friction igniter was located in the neck of the bottle. Total weight of the device was 8 lb.

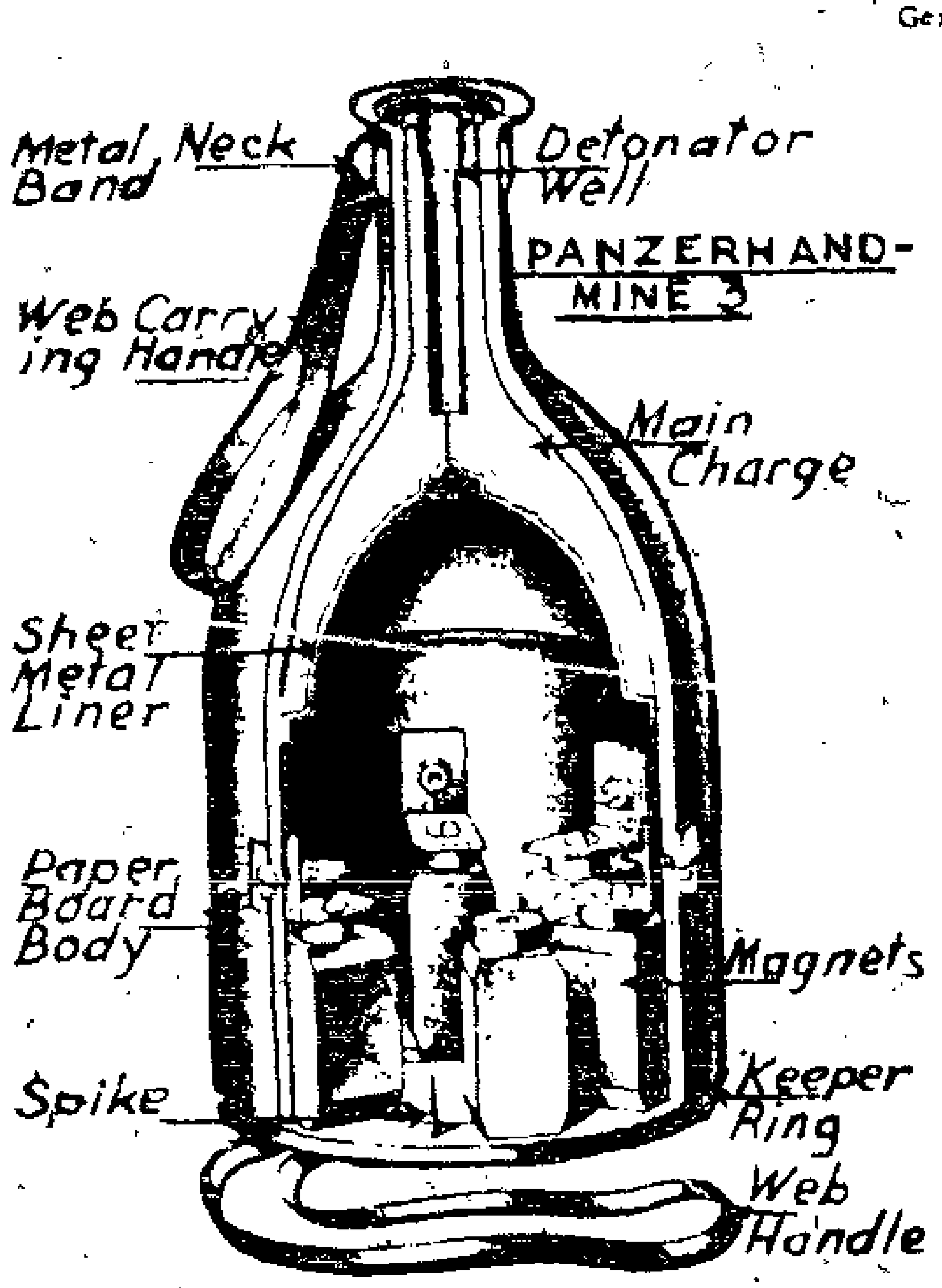
The device was apparently designed to be placed by hand on the tank and the igniter pulled after it has been positioned. If the target was of non-magnetic material such as wood, the charge could be attached by means of 3 spikes located at the bottom of the device. (pp 262-3).

HAFTHOHLLADUNG



HAND GRENADES





In another type of adhering (sticking) antitank hollow charge there were no magnets but a sticky pad (located at the wide part of the conical body) served for attaching the charge to a tank (Ref 1, p 324).

References:
1) Dept of the Army Tech Manual TM 9-1985-2 (1953), pp 262-3 & 323-4
2) H.H.Bullock, Picatinny Arsenal; private communication.

Haftmine (Adhering Mine). An antitank, hollow charge device consisting of a conical container (filled with HE), provided with a flat top and a handle. The wide portion of the cone was covered with a layer of a low melting colophony-oil plastic resin (m p ca 50°) retained on the surface by means of an open mesh cloth. In back of the flat top, which consisted of sheet metal, was placed a thermite-type charge ($Mg + Al + KClO_3$) and in back of the latter a time fuse. The operator hid in a hole and, at the approach of the tank, ignited the fuse which, in turn, ignited the thermite. Just as soon as the heat of the thermite melted the resin, the device was stuck (by the operator) to the bottom armor plate of the tank. At the same time the heat of the thermite set off the detonator and this in turn initiated the main charge.

This device was in an experimental stage when the war terminated.

Reference: E.E.Richardson et al, CIOS Rept 25-18 (1945), pp 23-5.

Halbklastit. Same as Petroklastit.

Haltbarkeit oder Lagerbeständigkeit (Stability in Storage). See in the general section.

Handfeuerwaffen (Small Arms). See under Weapons.

Handhabungssicheresprengstoffe (Explosives Safe to Handle and to Transport). See Davis (1943), p 347.

Harnstoff (Urea). See general section.

HC Mixture. A smoke mixture consisting of hexachloroethane and powdered zinc.
Reference: Anon, Field Artillery Journal 33, 352-3 (1943).

Heavy A/T Mine. See under Landminen and also on pp 265-7 of TM 9-1985-2 (1953).

Hebelzünder (Lever Type or Schuko Igniter). See Pressure Igniter under Igniter.

Hecht Guided Missile. See Pike (Hecht) Missile.

Hellhoff Explosive? According to Ger P 12,122 of 1880, it was prepared by the nitration of purified tar oil, followed by washing, drying and mixing of the nitrotar with oxygen carriers, such as K (or Na) nitrate (or chlorate), etc. It was claimed that this explosive mixture was very powerful.
Reference: See under Hellhoffit.

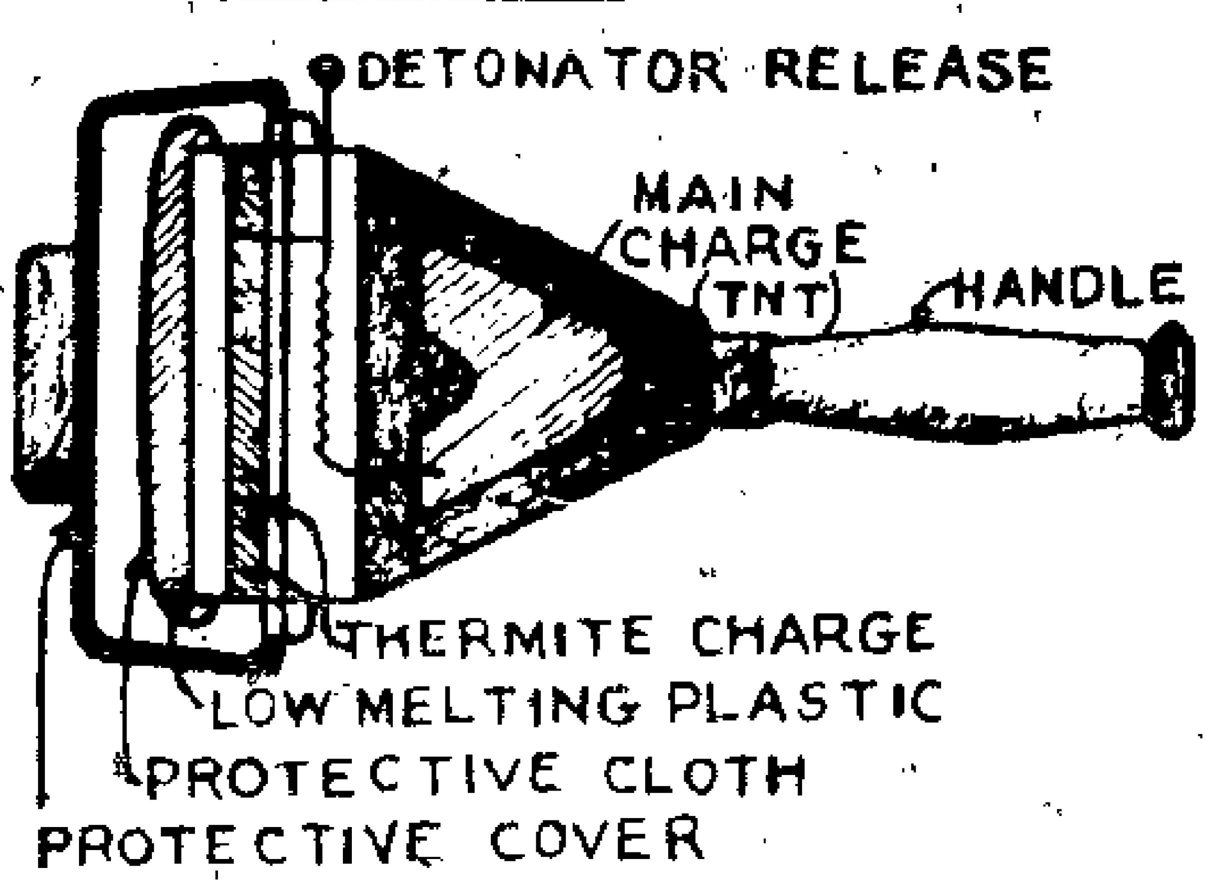
Hellhoffit (Hellhoffite). One of the Sprengel type explosives, invented about 1870 by Hellhoff and Gruson. It consisted of 28 parts of nitrobenzene and 72 parts of fuming nitric acid. This liquid was sometimes used absorbed on kieselguhr (see Guhrhellhoffit). The disadvantage of these Sprengel type explosives was their extreme corrosiveness (Ref 1).

According to Thorpe (Ref 2), Hellhoffit was tried in shells, the two ingredients being mixed during flight exploded on impact (see also Anilithe under French explosives).

Stettbacher (Refs 3 and 4) investigated Hellhoffit and its modifications and found that the glass-lined depth charges (Tiefenbomben) containing Hellhoffit, were much more effective than those loaded with picric acid. The mixture consisting of fuming nitric acid (d 1.52) 64.51, nitrobenzene 25.81 carbon disulfide 6.45 and aluminum bronze 3.23% was found to be one of the most effective. A mixture prepd by dissolving 66.7 parts of dinitrobenzene in 100 parts of fuming nitric acid was also claimed to be effective.

References:
1) Davis (1943), p 354 2) Thorpe's Dictionary, v 4 (1940), p 545 3) A.Stettbacher, S S 38, 158 (1943) 4) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 71.

HAFTMINE



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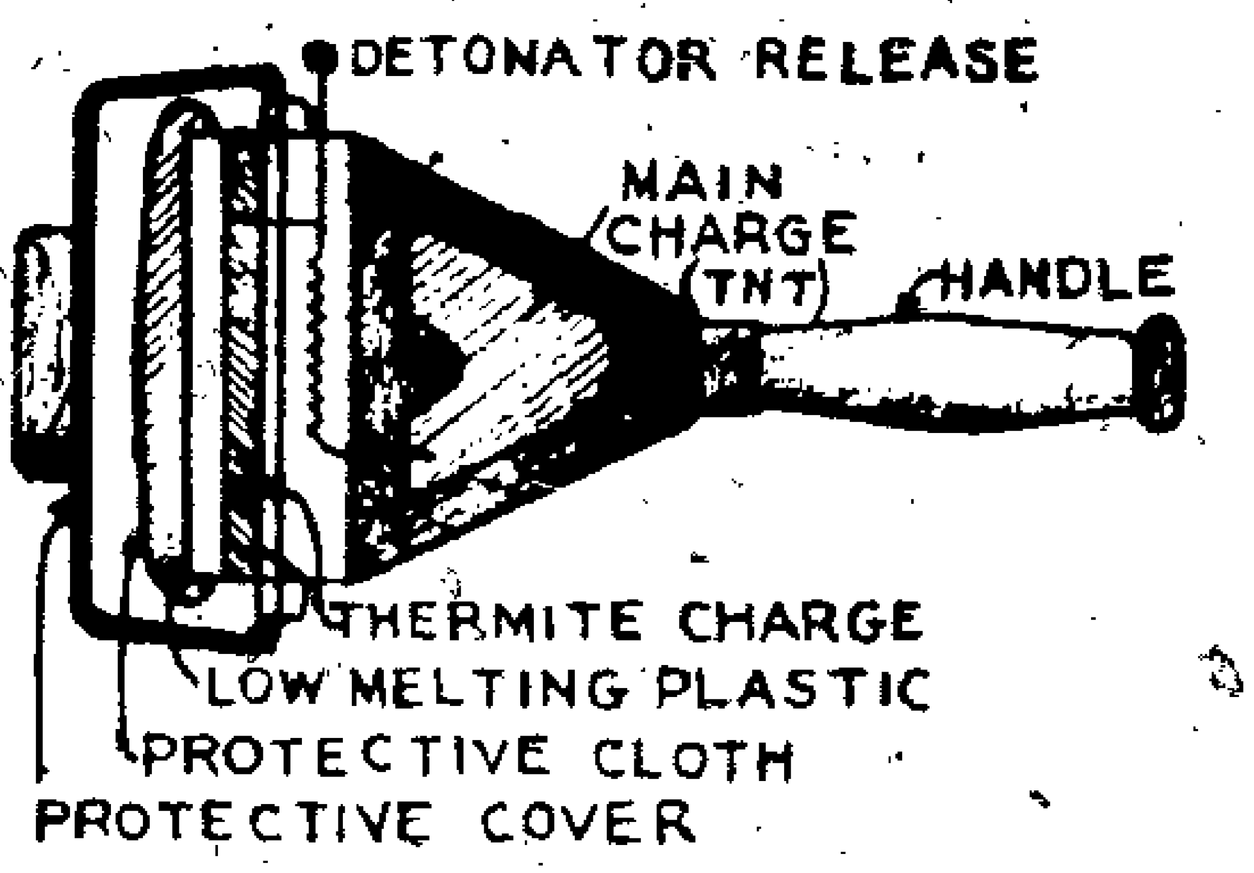
According to Thorpe (Ref 2), Hellhoffit was tried in shells, the two ingredients being mixed during flight exploded on impact (see also Anilithe under French explosives).

Stettbacher (Refs 3 and 4) investigated Hellhoffit and its modifications and found that the glass-lined depth charges (Tiefenbomben) containing Hellhoffit, were much more effective than those loaded with picric acid. The mixture consisting of fuming nitric acid (d 1.52) 64.51, nitrobenzene 25.81 carbon disulfide 6.45 and aluminum bronze 3.23% was found to be one of the most effective. A mixture prepd by dissolving 66.7 parts of dinitrobenzene in 100 parts of fuming nitric acid was also claimed to be effective.

References:
1) Davis (1943), p 354 2) Thorpe's Dictionary, v 4 (1940), p. 545 3) A.Stettbacher, S S 38, 158 (1943) 4) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 71.

HAFTMINE



Hengstit. Smokeless propellant, patented in 1888; was based on nitrated pulped straw previously treated with some chemicals as described in Daniel, Dictionnaire (1902), p 373.

Henschell or Hs. A guided missile (q v) developed during WW II.

Heraklin of Dickerhoff. An explosive prepd by soaking sawdust in a concentrated aqueous solution of equal parts of picric acid and Am nitrate. The resulting product was dried and mixed with various amounts of pulverized sulfur and K, or Na nitrates.
Reference: L.Gody, Traité des Matières Explosives, Namur (1907), p 551.

Hetzer (Baiter). A Czech designed and constructed Tank Destroyer, Jagdpanzer 38 (t) (See under Panzer).

Heuschrecke (Grasshopper). A series of weapon carriers (Waffenträger) such as for 105 mm Gun, developed by the Germans early in the WW II. They are described in vol III of the Illustrated Record of German Army Equipment 1939-1945, War Office, London (1947).
Note: The above British books were not consulted for fear that they are "confidential" or "secret" as is usual with British sources.

Hexa, Hexamin, Hexanitrodiphenylamin, oder Hexyl (Hexanitrodiphenylamine) (HNDPhA). Described in the general section under Diphenylamine. The following information concerning the manufacture and use of Hexa in Germany during WW II is available:

At Allendorf Fabrik of W A S A G. the method of manufacture was as follows:

To a charge of 1000 kg of 99% nitric acid placed in a V2A stainless steel nitrator of 2 cubic meter capacity (fitted with an agitator rotating at 60 RPM, a cooling jacket and cooking coils) 300 kg of diphenylamine was added gradually while the temperature was maintained at 90°. The solution was diluted with weak nitric acid and cooled to 30-40°. The precipitated HNDPhA was filtered off, washed thoroughly with water, then dried, screened and packed.

HNDPhA was used by the Germans at the start of WW I in an underwater explosive containing HNDPhA 40 and TNT 60%. During WW II, this explosive was replaced by the one containing HNDPhA 27.9, TNT 55.7 and Al 16.4%. Another underwater explosive contained HNDPhA 23.0, TNT 61.8 and Al 15.2%. Stettbacher (Ref 5) cites a mixture consisting of HNDPhA with 30-40% TNT and 16% Al (See also Hexamite, Schiesswolle 18, TSMV-1-101 and Ersatzsprengstoffe).

References:
1) A.Stettbacher, Protar (Switzerland) 9, 33-45 (1943)
2) U S Naval Tech Mission in Europe, Tech Rept 513-45. Hexanitrodiphenylamine Manufacture in Germany , PB Rept 38, 154 (1945)
3) O.W.Stickland et al, PB Rept 1820 (1945), pp 13-17
4) Anon, Allied and Enemy Explosives, Aberdeen Proving Ground, Md (1946)
5) A.Stettbacher, Spreng- and Schiesstoffe, Zürich (1948), pp 78-29.

Hexa S-22, S-26 and E-4. German substitute explosives containing hexanitrodiphenylamine described under Ersatzsprengstoffe.

Hexodi – German name for **Hexamethylenetetramine Dinitrate,** $C_6H_{12}N_4 \cdot 2H_2O$.(See KA-Verfahren under Hexogen).

Hexol. An explosive mixture consisting of 75% Hexogen (desensitized with 5% of wax) and 25% Al powder; was used in underwater ammunition. [PB Rept 1820.p 40].

Hexamethylentetramin (Hexamethylenetetramine) (HMeTeA), called also Hexamin, Methenamine, Aminoform or Urotropine. See general section.

Hexamethylenetetramine Derivatives (Explosives). To this group belong explosives containing Hexogen (RDX or Cyclonite) and R-Salz (Cyclotrimethylenetrinitrosamine) described elsewhere. In addition, G.Römer et al investigated two explosives (see Aliphatic Nitramines of WW II) obtained as by-products in the manufacture of Hexogen by the E-Salz and KA-Salz processes.

Both of these substances were claimed to be more powerful explosives than Hexogen.
Reference: G.Römer, PBL Rept 85,160 (1946), p 16.

Hexamethylenetriperoxidediamine (HMTPDA) (Hexamethylentriperoxyddiamin). Preparation and properties are given in the general section. The explosive was proposed in 1912 for use as initiating component for detonators. For instance, the No 8 copper cap might contain 0.1 g of HMTPDA and 1 g of TNT.
Reference: C. von Girsewald, Ger Pat 274,522 (applied for in 1912, issued in 1914).

Hexamin. One of the German designations for Hexanitrodiphenylamine. The same designation was used for Hexamethylenetetramine.

Hexamit, or Hexanit. An explosive used during WW I for cast loading torpedoes, sea mines, and depth charges. It consisted of hexanitrodiphenylamine (HNDPhA) 60-70 and TNT 40-30%. Its properties are described in the general section.

After termination of WW I, the Hexamit was used as a component of a commercial explosive known as "Neurodit".

The term Hexamit was also used for the following commercial explosive prepd from surplus materials of WW I: 60 to 90 parts of HNDPhA, in which might be present up to 40% picric acid, 10 to 40% DNT, TNT, and/or TNN, and 0 to 4% vegetable meal.
Reference: J.Pepin Lehalleur, Poudres, etc, Paris (1935), pp 457-8.
Note: According to TM 9-1985-2 (1953), p 15, the Hexamit was used in the warhead of Kurt Apparatus (q v).

Hexanit. Same as Hexamit.

Hexanitrodiathylnitramine. See general section under Diethylnitramine.

Hexanitrodiphenylamine. Same as Hexa.

Hexo. One of the abbreviations for Hexogen (H) (Cyclonite or RDX).

Hexo (S-19 and S-22). German substitute explosive containing Hexogen (RDX); described under "Ersatzsprengstoffe".

Hexogen or H(RDX), also called W-Salz, E-Salz, K-Salz, SH-Salz and KA-Salz, depending on the method of manufacture. It is described in the general section as Cyclonite (Cyclotrimethylene Trinitramine).

Although Hexogen was known in Germany since 1899 (Henning, Ger Pat 104 280, 1899), it was not used as an explosive until about 1935 when its manufacture was started using the W-Verfahren described below. Four other methods of manufacture were later introduced and production reached its peak with 7,700,000 lb produced during the month of June 1943. Out of the five methods developed in Germany and described briefly below, the so-called KA-Verfahren proved to be the best because it was the most economical, required less space and equipment and used readily available raw materials.

Following are the German WW II methods of manufacture, arranged in approximate chronological order:

1. **W-Verfahren** (W-Process), developed in 1935 by Dr Wolfram of the IG Farbenindustrie, was based on the reactions indicated by the following equations, starting from sulfur trioxide and ammonia:

a) $3SO_3 + 5NH_3 \rightarrow H_2N \cdot SO_2 \cdot ONH_4 + HN(SO_2 \cdot ONH_4)_2$

The resulting mixture of Am aminosulfonate and Am iminosulfonate was treated with a soln of Ca hydroxide, which gave a soluble Ca aminosulfonate and a ppt of Ca sulfate.

b) $H_2N \cdot SO_2 \cdot ONH_4 + HN(SO_2 \cdot ONH_4)_2 + 2Ca(OH)_2 \rightarrow (H_2N \cdot SO_2 \cdot O)_2Ca + CaSO_4 + 3NH_4OH$.

The liberated ammonia was recovered and used in reaction (a). The Ca sulfate was removed by filtration and the Ca aminosulfonate treated with K sulfate.

c) $(H_2N \cdot SO_2 \cdot O)_2Ca + K_2SO_4 \rightarrow 2H_2N \cdot SO_2 \cdot OK + CaSO_4$

The resulting K aminosulfonate was separated by filtration and treated with formaldehyde at 30° at a pH of 5.

d) $H_2N \cdot SO_2 \cdot OK + HCHO \rightarrow H_2C{:}N \cdot SO_2 \cdot OK + H_2O$.

The resulting condensation product, K methyleneaminosulfonate, called Weiss-Salz (White salt), was nitrated with mixed nitric-sulfuric acid at 30° in a stainless steel nitrator of 500 l capacity.

e) $3H_2C{:}N \cdot SO_2 \cdot OK + 3HNO_3 \rightarrow (H_2C \cdot N \cdot NO_2)_3 + 3KHSO_4$

This procedure (which under certain conditions gave yields up to 80% based on the formaldehyde used) was followed at the Krümmel Fabrik of Dynamit A-G until an explosion in 1943 completely destroyed the plant. Other German plants did not use the W-Verfahren because other methods such as the SH, KA and K proved to be more economical.

Note: A similar method was patented later by R.W.Schiessler and J.H.Ross, U S Pat 2,434,230 (1948).

2. **E-Verfahren** (E-Process), developed between 1935 and 1938 by Drs Eberle and Fischer, was based on the reaction of paraformaldehyde with Am nitrate, dissolved in acetic anhydride, which acted as a dehydrating agent:

$$(HCHO)_3 + 3NH_4NO_3 + 6(CH_3CO)_2O \rightarrow (H_2C \cdot N \cdot NO_2)_3 + 12CH_3COOH$$

The resulting Cyclonite was separated by means of a nutsch, from the acetic acid produced by the reaction, washed with water, stabilized and dried. The finished crystalline product had a m p of only 190-195°, and the yields varied between 60 and 75%, calculated on paraformaldehyde.

The E-Verfahren was used at the Bobingen Fabrik, Dynamit A-G and produced 125 metric tons per month. It was replaced in 1944 by the KA-Verfahren which enabled the production to be doubled with the same equipment.

Note: The Cyclonite obtained by this method contained the same impurities as described under KA-Verfahren but in larger amounts.

3. **SH-Verfahren** (SH-Process), developed in 1937-1938 by Dr Schnurr was based on the original method of Henning (1899), which involved direct nitration of hexamethylenetetramine (called also hexamine or urotropine) with nearly absolute nitric acid, according to the following equation:

$$C_6H_{12}N_4 + 6HNO_3 \rightarrow (H_2C \cdot N \cdot NO_2)_3 + 6H_2O + 3CO_2 + 2N_2$$

A similar method was independently developed by Dr G.C.Hale at Picatinny Arsenal.

The improvement introduced by Dr Schnurr consisted in carefully controlled heating ("cooking-off") of the contents of the nitrator directly after the completion of the reaction. Under these conditions the unstable products formed during the reaction were partly decomposed and partly nitrated to cyclonite.

The nitration in the SH-process was conducted at -5° using white 99% nitric acid. The purified Cyclonite had a m p between 200° and 202°C.

While in the original (Henning's) method the yield was very low (about 40% based on $C_6H_{12}N_4$ used), the improved method was much more economical (yields up to 71.5% were reported).

The SH-process was used in at least three plants all of them belonging to the Dynamit A-G: Christianstadt (producing up to 3000 metric tons per month), Döberitz (producing up to 500 to/mo) and Ückermünde (producing up to 250 to/mo). The SH-process was considered to be more economical than the W-, E- or K- processes, but inferior to the KA-process.

4. **K-Verfahren** (K-Process), developed by Dr Knöffler of WASAG, somewhat later than the E-Verfahren, was based on the following consideration: "As the hexamethylenetetramine contains $6CH_2$- groups and only $4NH_2$- groups, there is a deficiency of two NH_2- groups which are required for the production of each two molecules of Cyclonite, this can be remedied by introducing into reaction two mols of Am nitrate as shown in the following equation:

$$C_6H_{12}N_4 + 4HNO_3 + 2NH_4NO_3 \rightarrow 2(H_2C \cdot N \cdot NO_2)_3 + 6H_2O$$

Nitric acid of 99% strength was used and was required in larger quantity than for the other methods. This made the recovery of spent acid a very difficult and expensive problem. Only one German plant used this method (Elsnig Fabrik of WASAG), producing 200 metric tons per month.

5. **KA-Verfahren** (KA-Process), developed by Dr Knöffler of WASAG was actually a combination of parts of the K- and E- processes. It consisted in treating the hexamethylenetetramine dinitrate with acid Am nitrate in acetic anhydride, as can be seen from the following equations:

a) $C_6H_{12}N_4 + 2HNO_3 \rightarrow C_6H_{12}N_4 \cdot 2HNO_3$ (Hexamethylenetetramine dinitrate).

b) $C_6H_{12}N_4 \cdot 2HNO_3 + 2NH_4NO_3 \cdot HNO_3 + 6(CH_3CO)_2O \rightarrow 2(H_2C \cdot N \cdot NO_2)_3 + 12CH_3 \cdot COOH$

In this method, considered to be one of the most economical, paraformaldehyde was not used, because all the necessary CH_2- groups were supplied by hexamethylenetetramine. A similar procedure was developed in the U S A by W.E.Bachmann (See general section under Cyclonite).

In the KA-process, as practiced at the Bobingen Fabrik, hexamine was treated with weak nitric acid (35-50%) at about 5° and the resulting dinitrate (called in Germany Hexadi), was dried. The dry product was dissolved in acetic anhydride (using a stainless steel vessel equipped with a paddle-type stirrer) and then acid Am nitrate (previously prepd by treating Am nitrate with 1 mol of 100% nitric acid) was added. The resulting solid product was separated from acetic acid, then washed with water and dried. The cyclonite obtained by this method was called KA-Salz. It contained, as impurities, 1 to 2% of HMX (cyclotetramethylenetetranitramine, called in Germany Octogen), $(H_2C \cdot N \cdot NO_2)_4$ and a small amount of cyclotrimethylene dinitromonoacetylamine, $(CH_2)_3N_3(NO_2)_2 \cdot OCH_3$. Higher percentages of these impurities were produced when the E-Verfahren was used.

Note: The advantage of the KA-process over the E-process was that by using hexamine instead of paraformaldehyde only half of the amount of water was produced, thus requiring a much smaller amount of acetic anhydride. Hence, it was possible, without increasing the size or amount of equipment, to increase the production of the Bobingen Fabrik, Dynamit A-G from 125 to 250 metric tons per month when the method was changed in 1944 from the E- to the KA- process.

Yields, when calculated on the basis of formaldehyde (from which the hexamine was produced), were 80-82% for the KA-process, as against 73-75% in the E-process. In the KA-process the production of 100 parts of Cyclonite required 40p of hexamine, 43p of Am nitrate, 68p of nitric acid and 240p of acetic anhydride (of which 195p were recovered as acetic acid).

A recent article of Mayer (Ref 5) described some German methods of preparation of RDX and lists its properties as follows: m p 201-3, d 1.82, explosion temperature 230°, impact sensitivity with 2 kg weight 40-45 cm, velocity of detonation 8400 m/sec.

Straight Hexogen was used by the Germans as a booster, sub-booster and as a bursting charge in rifle-grenades and some small caliber shells. It was also used with a small amount of wax, e g, 3%, as a sub-booster in the African campaign to replace PETN-wax mixtures. With a larger amount of wax, e g, 10.3%, it was used in 75 mm shells. Hexogen was also used with other proportions of wax as well as with TNT, Al etc. [See Fillers Nos 86, 89, 90, 91-H5, 92-H10.3, 92-H3, 95-H/Ep 02, 105 (or Trialen 105), 106 (or Trialen 106) and 109 (or Trialen 109), described under Fillers].

References:

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The mixture was put out in cylinders about 220 mm long by 28 mm in diameter. Due to difficulty with direct cap initiation, a booster was provided. It consisted of compressed, phlegmatized PETN pellets about 40 mm long by 21 mm diam and equipped with a detonator well 20 mm deep.

Note: This explosive was developed as a substitute for the plastic explosive, which used RDX plus American vaseline, because the latter component was no longer available in Germany. This vaseline, called "long fibrous" by Meyer, had much greater adherence than vaselines manufactured in other countries.

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Hexyl. Same as Hexa.

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Hochdruckpumpe oder V-3 (High Pressure Pump, called also "Busy Lizzie" or "Multipede") was a constant-pressure gun developed during WW II by Conders, an engineer of the firm Röchling, Saarbrücken, and intended to fire the Arrow (Needle) Projectile (q v) across the Channel to London. The barrel, caliber 150 mm (5.9"), was of unalloyed crucible cast steel made up of a great many Y-shaped sections, each 12 to 16 ft long. With the gun about 450 ft long containing about 28 propellent chambers (distributed along the bore), it was expected to achieve a muzzle velocity of about 4500 ft/sec and a range of about 130 km (when using a projectile 8 ft long and weighing 150 lb).

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... minosulfonate and Am
... mole of Ca hydroxide,
... onate and a ppt of Ca

... $NH_4)_2$ + $2Ca(OH)_2 \rightarrow$
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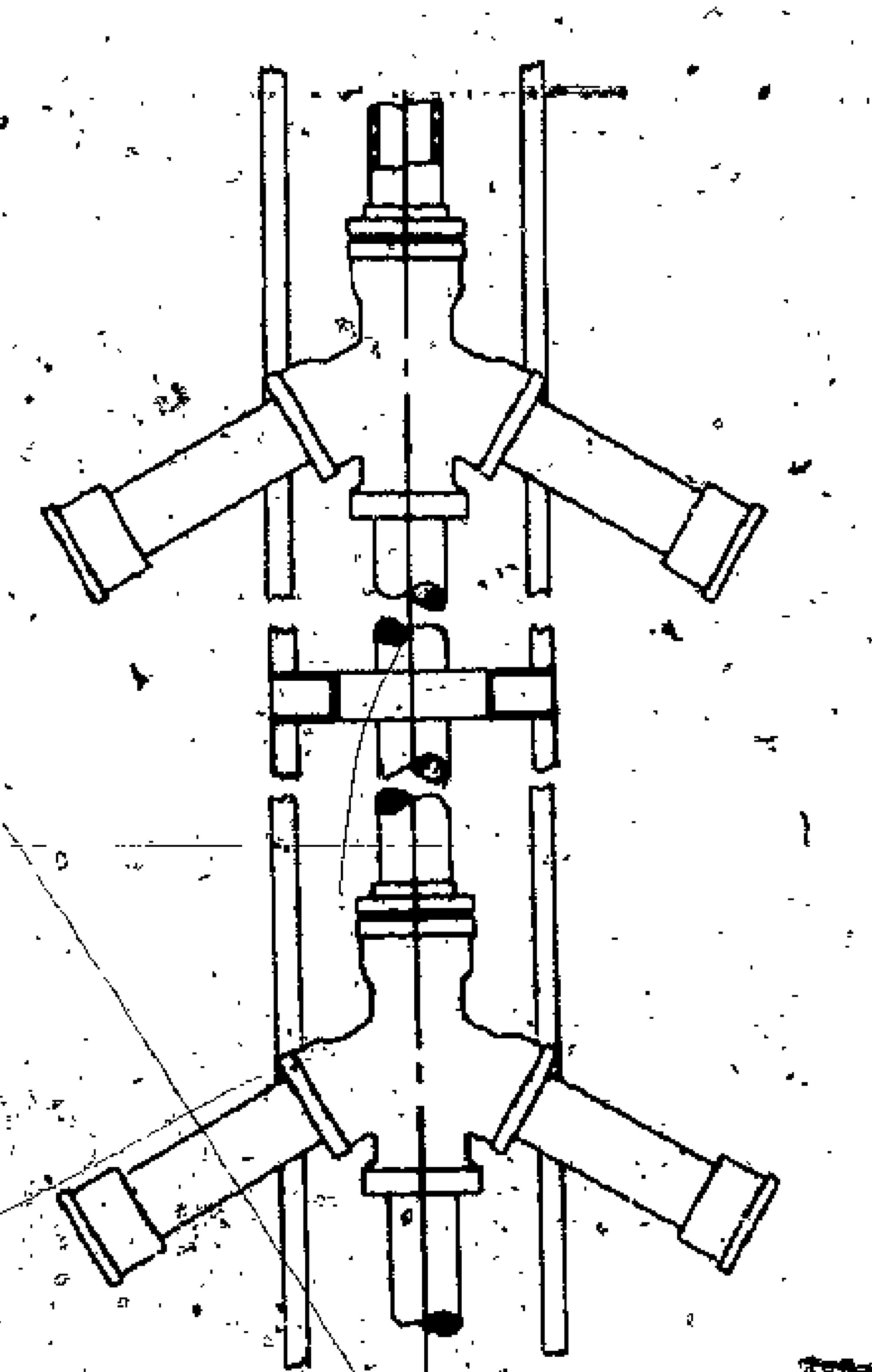
Hochdruckpumpe oder V-3 (High Pressure Pump, called also "Busy Lizzie" or "Millipede") was a constant-pressure gun developed during WW II by Couders, an engineer of the firm Röchling, Saarbrücken, and intended to fire the Arrow (Needle) Projectile (q v) across the Channel to London. The barrel, caliber 150 mm (5.9"), was of unalloyed crucible cast steel made up of a great many Y-shaped sections, each 12 to 16 ft long. With the gun about 450 ft long containing about 28 propellent chambers (distributed along the bore), it was expected to achieve a muzzle velocity of about 4500 ft/sec and a range of about 130 km (when using a projectile 8 ft long and weighing 150 lb).



HDP SUPERGUN
(VERGELTUNGSWAFFE 3)
(V-3)

The gun could lie on the ground without any carriage on wooden and concrete blocks sloped at a 45° angle. The fin-stabilized, arrow projectile was inserted in the barrel and the base propellent charge electrically ignited. As the projectile passed the separate Y-pieces, additional propellent charges in the side arms were electrically ignited one after another (in pairs) thus accelerating the velocity of the projectile as it progressed along the gun barrel.

For servicing (reloading the Y- sections with propellent charges between the rounds), the gun required a great many soldiers. It was planned to fire one round per gun every 5 minutes but this rate could not always be achieved because the sections often exploded and it was necessary to insert new Y- pieces.

References:

1) L.E.Simon, German Research in World War II, J.Wiley, N Y (1947), pp 191-3
2) W.Dornberger, "V-2", Viking, N Y (1954), p 247
3) A.I.Sprinz and H.H.Bullock of Picatinny Arsenal; private communication.

Hochexplosivkörper oder Blitzstoffe (High Explosives) (HE). See general section.

Hoch- und Niederdruckkanone (High and Low Pressure Gun, abbreviated to H/L Gun) (Canon à tuyère, in French). It has been known for a long time that the lower the peak pressure in a gun the thinner may be the walls of the projectile. This means that for a given total weight of a projectile, that used in a gun with lower peak pressure can contain more explosive and do more damage to a target.

This is of particular importance in the use of shaped charges because the penetration of targets does not depend upon the strength of the case (shell) but on the amount of the explosive charge. In order to achieve low pressure in a gun of conventional design, the barrel should be made longer and the chamber and cartridge case larger. Such guns were built but were found to be unsuitable because the propellant was difficult to ignite and it burned irregularly (due to the low pressure in the chamber). Also, the initial velocity of the projectile varied from round to round which means that no precision firing could be achieved.

Better results were obtained in 1943 when Dr Hermann and collaborators of the Rheinmetall-Borsig A-G constructed the 8 cm PWK 43 (80 mm Antitank Gun). The description of this gun called in French "canon antichar modèle 1943", was given by Travers and Touchard (Ref 3). They claim that the "turbocanon Delamare-Maze" invented in France about 20 years earlier may be considered as the predecessor of both the H/L and recoilless guns.

The German gun 8 cm PWK 43 had a comparatively thin barrel with an inside diameter of 81 mm and was 34 calibers long; the chamber had an enlarged diameter (105 mm) and much thicker walls. The projectile (fin-tail type, 81 mm in diameter, contained a shaped charge and weighed 3kg) was inserted first in the bore (as in separate-loading ammunition). This was followed by the cartridge (120 mm long and 105 mm in diameter) which contained the propellant. The cartridge was closed by means of a disc provided with eight perforations (each 13 mm in diameter). When the propellant burned the pressure of the gases developed inside the cartridge was about 850 kg/cm^2 but the pressure acting on the projectile was only 550 kg/cm^2 because the gases lost part of their velocity on passing through the holes in the disc.

The relation between the high pressure inside the cartridge case and the lower pressure in the bore could be varied by increasing or decreasing the size or number of the openings in the separating disc. In order to protect the propellant in the container from spilling and from moisture, the perforated metallic disc was covered with a solid disc of paraffined cardboard.

The ballistics for the H/L gun were worked out by Travers and Touchard in France and by Corner in England.

Note: Corner states that towards the end of WW II the Germans started to manufacture two light antitank guns: the 8 cm PAW 600 and the 10.5 cm PAW 1000, but does not describe them. He also mentions the 8.8 cm W71 gun, which was built on the "three-pressure principle".

References:

1) J.Corner, J Franklin Inst 246, 233 (1948) 2) J.Corner, Theory of the Internal Ballistics of Guns, J.Wiley, N.Y (1950), pp 312-327 3) S.Travers & L.Touchard, Mém Artil Fr 26, 835-58 (1952) 4) Ibid, 27, 219-36 & 245-78 (1953).

Hohlladung (Shaped or Hollow Charge). Considerable work was done in Germany before and during WW II on the development of shaped charges. Among the most prominent contributors in this field were the personnel of Krümmel Fabrik, DAG. Among the shaped charge weapons developed at Krümmel may be mentioned:

a) Magnetic anti-tank shaped charge weighing 3 kg; blast penetration of armor was up to 250 mm

b) Shaped charges for Faustpatrone, Panzerfaust, Panzerschreck etc.

Note: At Krümmel it was found that the best explosives for shaped charges were RDX-TNB and next, RDX-TNT mixtures. Substituting PETN for RDX lead to a decrease in efficiency. The addition of aluminum powder was desirable but not in large quantity.

Krümmel was not the only place where work on shaped charges was conducted. Elsewhere the Germans developed a shaped charge shell which was shot from an 80 mm mortar called "Panzerwurfkanone", and the warheads for several guided missiles.

Historical. Discovery of the hollow (shaped) charge (HoC) effect is usually attributed to C.E.Munroe (USA) who described the effect in the Amer J Sci 36, 1888. It was claimed by H.Schardin that Max von Forster of Germany had in 1883 already shown that bare hollow charges gave an enhanced effect along the axis of the charge. The first practical application of the HoC effect for demolition charges, sea mines, torpedoes, projectiles etc, was patented in 1910 by E.Neumann & the Westfälisch-Anhaltische Sprengstoff A-G (DRP Anm W36269). Neumann's work is described in SS 6, 356(1911) and SS 9, 183(1914). Important work on military applications of the HoC effect was done, prior and during WWII, by H.Schardin et al in Berlin. Some work was also carried out by A.Stettbacher of Switzerland duridg this period.

Note: According to A.J.Dere, Ordnance Sergeant, October 1945, pp 3-13, hollow (shaped) charge ammunition was used by the Germans in many 75 mm caliber weapons. There were at least four types of such projectiles: HI, HI/A, HI/B and HI/C. Most of these projectiles are listed in this dictionary under Granate and are briefly described in TM 9-1985-3 (1953). Some projectiles of calibers 88 mm, 100 mm, 105 mm and 150 mm also had shaped charges.

The enclosed drawings represent some typical German hollow charges. (See next page).

References:

1) A.Stettbacher, Nitrocellulose 8, 83-84 (1937)

2) O.W.Stickland et al, PB Rept 925, Appendix 3, p 46 and Appendix 7

3) L.E.Simon, German Research in WWII, Wiley, N Y (1947), pp 118-120, 188

4) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 133-34

5) H.L.Porter et al, CIOS Report 33-27 (1945). This report is classified and information contained therein has not been used for this dictionary.

(See also Shaped Charge in the General Section)

"**Hoko**" (Hochkonzentriert = Highly-concentrated) Process for the manufacture of 98-99% nitric acid, developed during WW II, was used in several German plants. In this process, the concentration of the weak acid (50%) was effected by mixing it with liquid nitrogen tetroxide (N_2O_4) and adding the necessary extra oxygen under 50 atm pressure in an autoclave.

Description of this method as practiced by the IG Farbenind A-G subsidiary, the Wirtschaftliche Forschungsgesellschaft, mbH (WIFO), Embsen, Kr Lüneburg is given in the following BIOS Final Reports: 1232 (1947), pp 15-16 and 1442 (1947), pp 84-98.

Hollow Charge. See Hohlladung.

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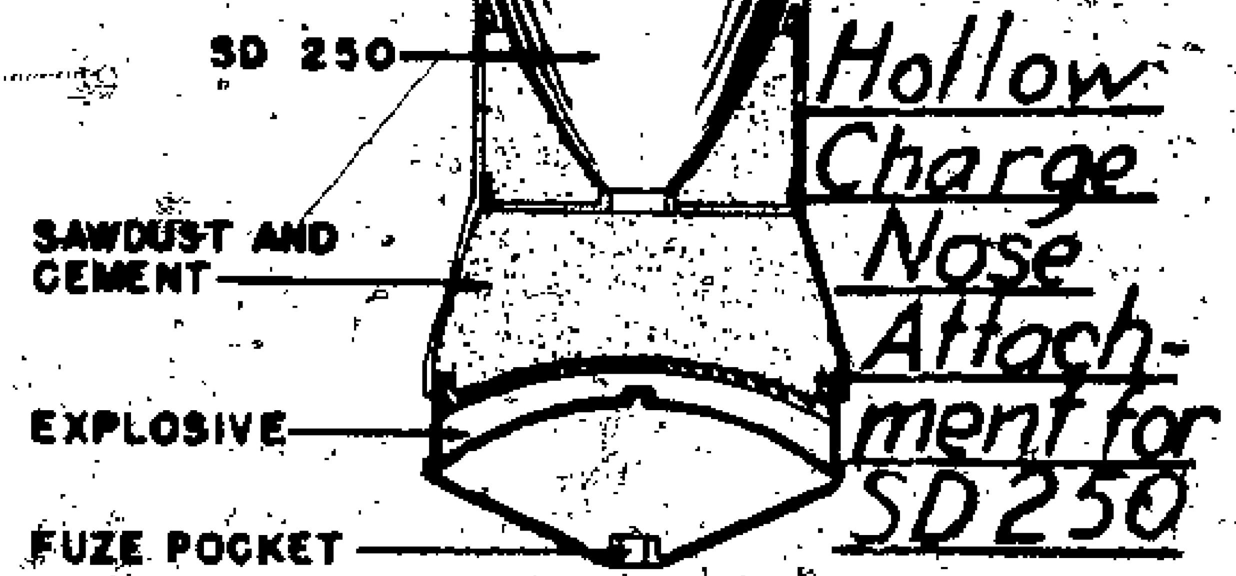

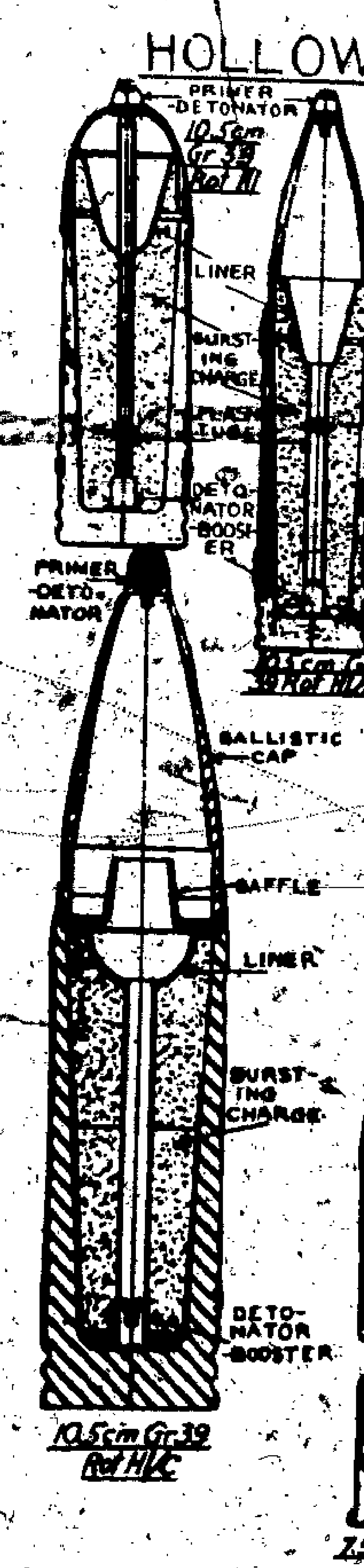

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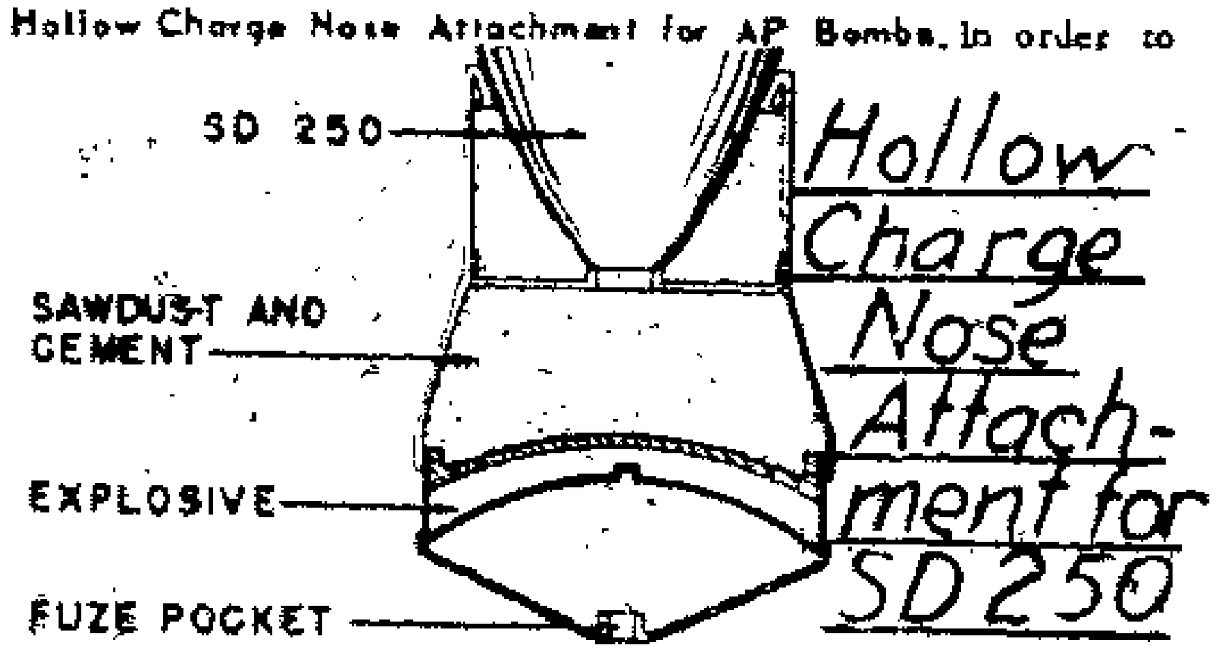
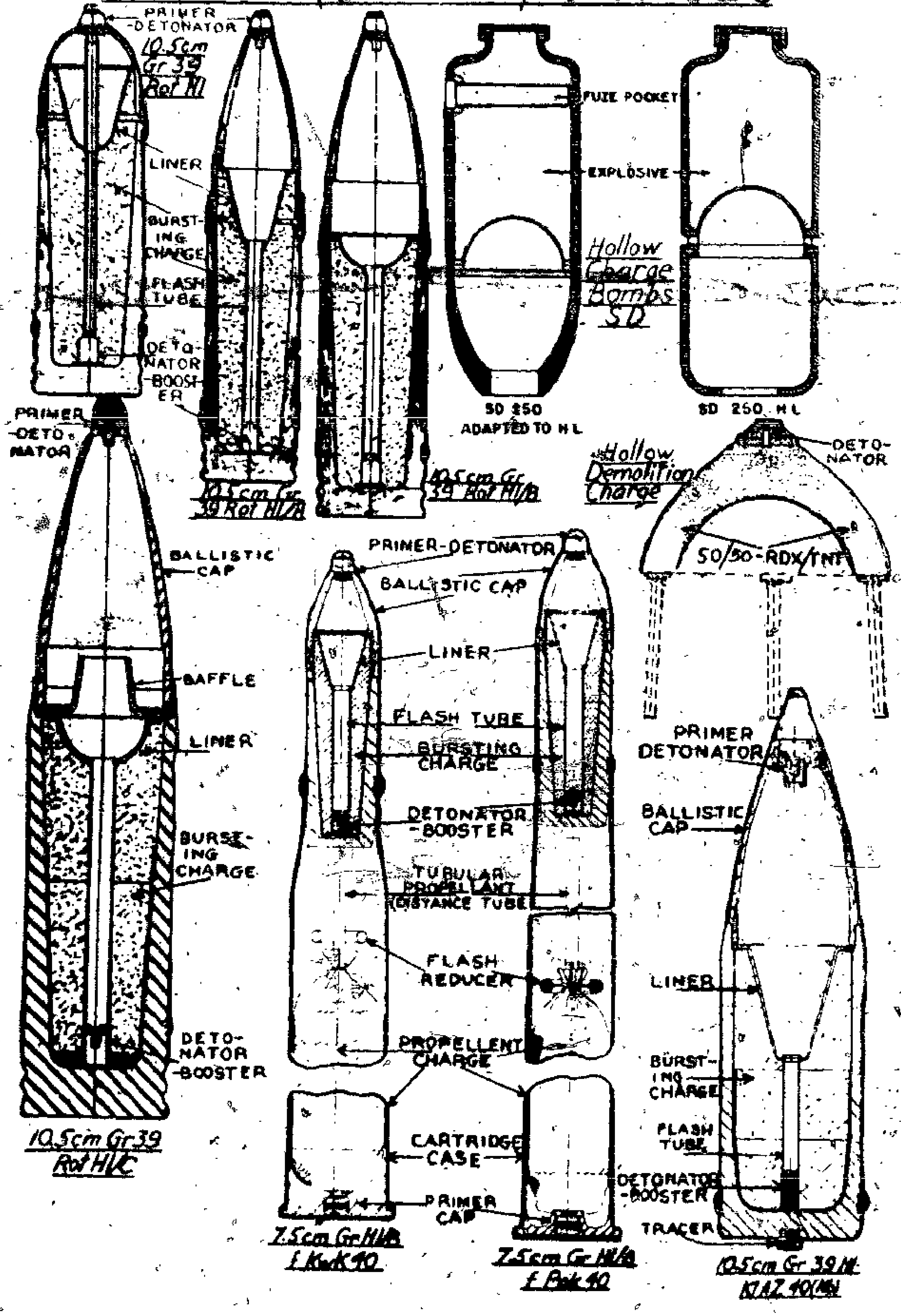


Hollow Charge Nose Attachment for SD 250

HOLLOW (SHAPED) CHARGES



permit greater penetrating power from low altitudes some German 250 kg AP bombs had a hollow charge (weighing about 4 kg) attached to the nose. This charge was detonated by its own nose fuze as soon as it hit the armor. The explosion of the HoC produced a hole in the armor (as deep as 7 cm) which permitted the AP bomb to enter inside the target. The AP bomb being provided with a short delay fuze did not explode until it was inside the target. In order to protect the bomb from premature detonation the space between the HoC and the nose of the bomb was filled with sawdust and cement.
Reference: TM 9-1985-2 (1953), p 5.

Holzgeist (Wood Spirits). See Methanol in general section.

Holzmehl (Wood Meal). See Wood Flour in the general section.

Holzmine 42. See under Landminen and also on p 263 of TM 9-1985-2 (1953).

Holzpech (Wood Pitch). See general section.

Holzstoffmasse (Wood Pulp). See general section.

Holzteer (Wood Tar). See general section under Tar.

Holzzellstoff (Wood Cellulose or Chemical Wood Pulp). See general section.

Homing Guidance Systems for Missiles, such as Acoustic, Radar and Infrared are briefly described under Guidance Systems for Missiles.

Howitzer (Haubitze). See under Weapons.

Hs 117 (Henschel 117), also known as Schmetterling (Butterfly), was a rocket propelled, radio controlled, missile for use against bomber formations. Some versions were for ground-to-air and some for air-to-air. It used liquid fuel called Tonka and an oxygen carrier called Salbei.
[TM 9-1985-2 (1953), pp 196-201].

Hs 293 (Henschel 293) was a radio-controlled missile released and directed to the target from an aircraft. The model fully developed and used was the Hs 293 A-1. Other models such as Hs 293 A-2, Hs 293 B, Hs 293 C, Hs 293 D, etc were not fully developed. [TM 9-1985-2 (1953), pp 201-3].

Hs 298 (Henschel 298) was a rocket-propelled, radio-controlled missile designed primarily as an air-to-air weapon to be carried on fighter aircraft as well as the bomber types. There were several versions but the basic type was called Hs 298 V-2. It used a solid propellant.
[TM 9-1985-2 (1953), pp 203-5].

HTA. An abbreviation for mixtures of RDX (Hexogen), TNT (Trotyl) and Al (aluminum), such as in the proportions 40/40/20. [See also PBL Rept No 85,160 (1946), p 15].

Hübner Propellants, patented in 1895, were prepd by mixing NC (gelatinized by means of 2-3% soln of K xanthogenate in ether-alcohol) with small quantities of nitronaphthol, nitromolasses, or nitrosugar. For instance, a propellant used for military purposes contained 4 to 5% of nitronaphthol [Daniel, Dictionnaire, Paris (1902) p 378].

Hummel (Bumble Bee). Nickname for a self-propelled mount consisting of 150 mm Medium Howitzer on the chassis of a PzKpfw III/IV tank. (See also under Panzer).

Hydrazine, Hydrate is described in the general section. Its manufacture in Germany at the IG Farbenindustrie Plants at Gersthofen, Leverkusen, Ludwigshafen ... is described in BIOS Final Report ... (1946).

Hydrocellulose or Hydrozellulose (Hydrocellulose). Described in the general section. It was reported that the Germans used it in some rocket propellants presumably to improve the burning characteristics. For instance the so-called Ammonpulver contained 5% hydrocellulose and the EP (Einheitspulver) contained about 3%. Hydrocellulose was also used in some rocket propellants to increase the rate of burning at low temperature. (See Standard Propellant).
Reference: CIOS Report 31-68 (1945), pp 6-7.

Hydrogen Peroxide (Wasserstoffsuperoxyd). Its preparation and properties are described in the general section under Peroxides. It was used in liquid rocket propellants and in a special turbine designed for submarines by Walter. Several German methods of manufacture are described in the following References:
1) B.E.A. Vigers et al, Hydrogen Peroxide Production by Electrolysis of 35 Per Cent Solutions (Deutsche Gold und Silver Anstalt), BIOS Final Report 683 (1945)
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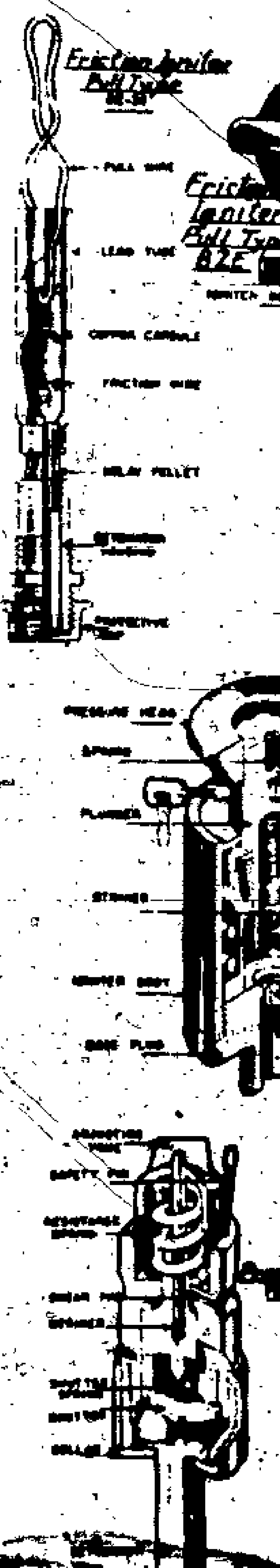
4) J. McAulay, Direct Synthesis of Hydrogen Peroxide by Electric Discharge, CIOS Rept 33-44 (1945).
[See also T-Stoff, Rocket Propellants, Liquid and U-Boat (Unterseeboot) of Walter].

Hygroskopizität oder Feuchtigkeit (Hygroscopicity, Humidity or Moisture). Methods of determination are given in the general section.

Igniter (Zünder). The following igniters are briefly described or listed in Refs 1, 2 & 3

A. **Friction (Pull) Type** (Brennzünder).
a) BZ 24, with delay pellets, was used in stick grenades (Ref 1, p 83.13 & 3, p 283)
b) NbBZ 38, with delay pellets was used in smoke grenades (1, p 83.13 & 3 p 283)
c) BZE, with pellet, was used with egg grenades, shaving stick grenades and message box flares (1, p 83.12 & 3, p 284)
d) BZ 39, used in smoke hand grenades (3, p 285)
e) ZdSchn ANZ 29, used to ignite safety fuses or detonators, to set booby traps, to ignite safety fuses for some demolition charges, to ignite some smoke candles and to booby-trap some Teller mines and grenades. (1, p 83.10 & 3, p 285)
f) ZdSchnANZ 39, used for the same purposes as above (1, p 83.11 & 3, p 285)
g) BZ 42, delay 4½ sec; uses not indicated (1, p 165)

B. **Pressure Type** (Druckzünder).
a) DZ 35(A), used in heavy antitank mines and some prepared charges (1, p 83.03 & 3, p 295)
b) DZ 35(B), used in some booby traps and prepared mines (1, p 83.03 & 3, p 296)
c) **Hebelzünder** (Lever Igniter), also called **Schuko Igniter**, consisted of an inverted L-shaped tube, the vertical arm of which was screwed into a mine. The horizontal arm contained the percussion cap, striker, striker spring and striker retaining pin. On top of the arm was attached a lug, an actuating lever (consisting of a hollow metal tripping piece pivoted on a rivet), and a safety pin. After removing the pin, the downward pressure (as little as 40 lb) on the ... lever forced out the striker retaining pin, thus releasing the striker to fire the percussion cap. The igniter was used in Glasmine 43 ... to the Buck Igniter) and in some booby traps (1, p 83.14 & 3, p 296)
d) ..., used in some improvised mines (1, p 83.03 & 3, p 297)
f) **Weissmann Igniter** consisted of a spring loaded striker bolt at the top of which was a pressure head. The bolt was held against the spring by a safety device consisting of a small pair of tongs. After removing the tongs, pressure or a blow on the pressure head shattered the glass rod thus allowing the spring to drive the



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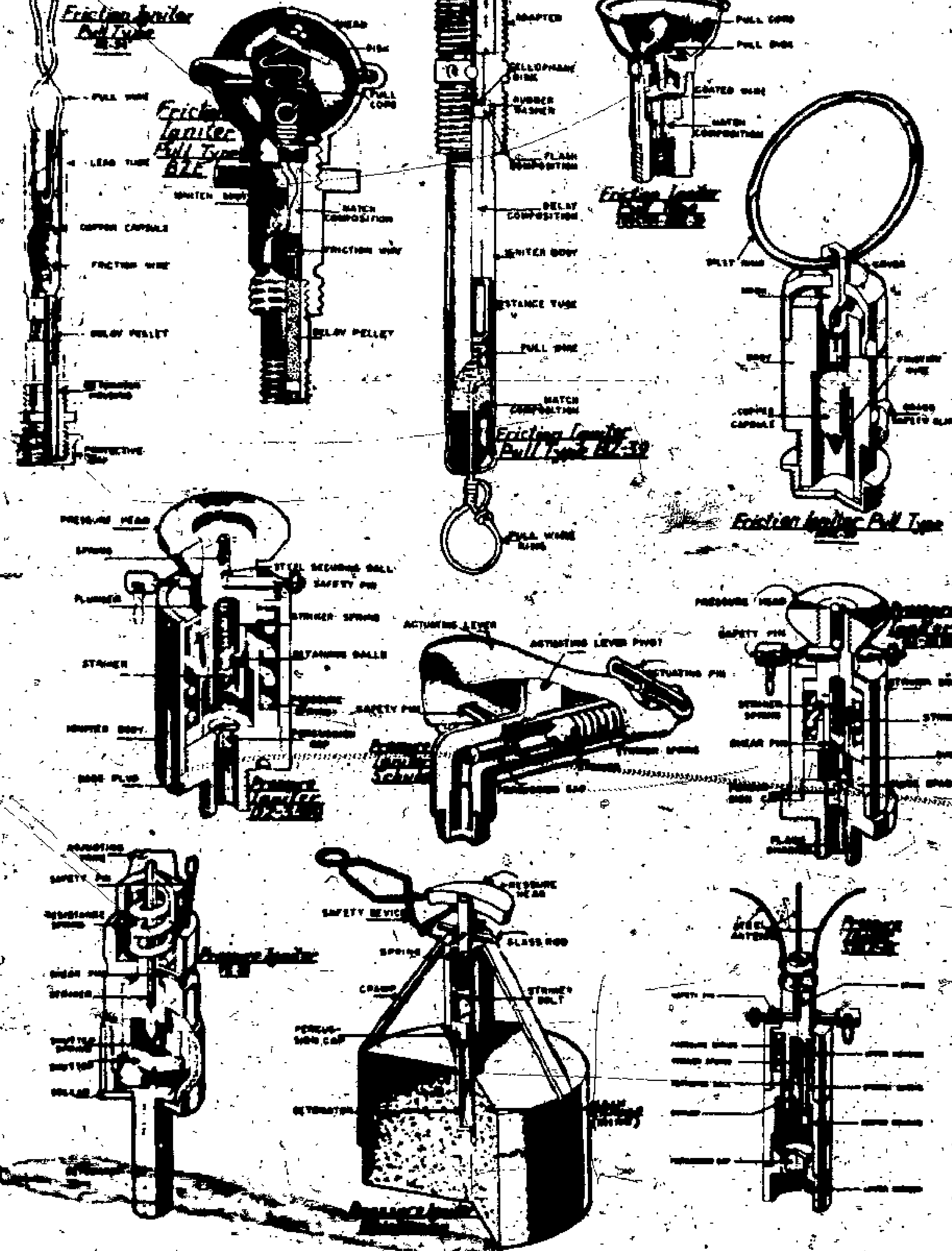

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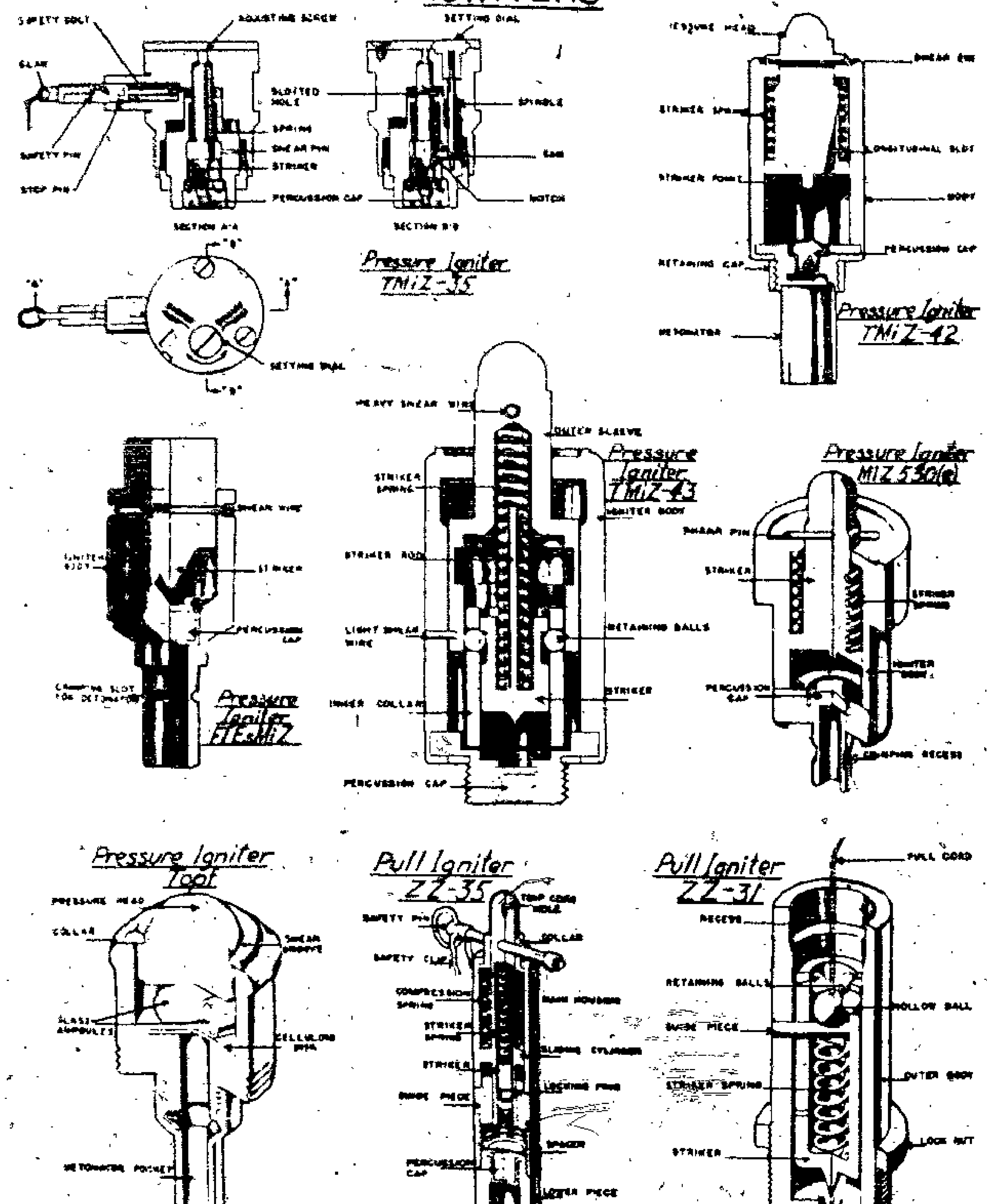

striker against the percussion cap etc. The ig
designed for use as a push igniter in improvis
or as an impact igniter for HE charges when u
assault (3, p 298)
g) SMiZ 35 designed for use in Schützenm
called Bounding Mine (3, p 299)
h) TMiZ 35 (Tellerminenzünder 35), used in
(3, p 301)
i) TMiZ 42, used TMi-35 (steel), TMi 42 and
also called Pilzmine (Mushroom Mine) (3, p 303)
j) TMi 43, used as above (3, p 304)
k) FlEsMiZ used in Flascheneismine 42 (Anti
glass bottle mine) (3, p 307)
l) MiZ 530(e); an igniter manufd in Germany
in the British Antitank Mine 530 (3, p 305)
m) **Topfminenzünder** (Pot Mine Fuze) consis
hollow, cylindrical, glass body into which
solid pressure head. Inside the cylinder were
two glass ampoules containing liquids which c
ignited the explosive train of the Pot Mine (T
A pressure of about 150 kg was sufficient
the ampoules (3, p 306)

C. Pull Type (Zugzünder).
a) ZZ 35, used in S-Mines, some prepared
booby traps employing trip wires) and for booby
of Teller mines (1, p 83.04 & 3, p 288)
b) Type 31 designed for use in antipersonn
and booby traps (3, p 289).

D. Pull and Shear Type (Zug- und Zerschnei
also called **Pull and Tension Wire Igniter,**
ZuZZ 35, consisted of a brass case containi
cussion cap, striker, striker spring (located
sliding cylinder and held on top by a plunger),
compression spring, a retaining (locking) p
safety pin. The top of plunger was connec
trip wire held under tension. The igniter
either by pulling on the trip wire or by loosenin
or breaking) it. In the first case the trip wi
the plunger to be pulled upward against the r
of the outer spring. This permitted the tw
pins to be forced outward into the upper op
thus freeing the striker. In the second case,
or cutting of the trip wire allowed the outer (com
spring to force the sliding cylinder downwa
permitted the locking pins to be forced outw
the lower open space, thus freeing the stri
igniter was used with S-mines, booby traps
pared charges. (1, p 83.05 & 3, p 293)

E. Percussion Type (Schlagzünder oder Aufschla
a) Schlagzünder 35 was a modified version of
uses not indicated (2, p 163)
b) Safety Fuse Igniter consisted of a cylindr
body containing a spring-loaded striker held in
by a friction fit of the Z type with a cap to
attached a large steel ring. A strong pull on
detached the striker release plate from the st
permitting the spring to drive the striker into
cussion cap. The device was used to ignite a s
(3, p 287)
c) **Type 2 (Pull Percussion) Igniter** was des
use with the new type parachute antiperson
but was suitable for use with mines and boo
For operation, a sharp pull on the split ring c
striker release plate to be drawn from the ig
thus releasing the striker spring, which w
tension (3, p 288)
d) Aufschlagzünder 355(h) for use in Dutch
Mine 355 (2, p 164)

F. Pull and Pressure Type (Zug- und Druckzünd
a) ZDZ 29 Igniter, used in the assembly of
antivehicle or antipersonnel mines, could be
either by pull on a trip wire attached to th
the pull pin, or by pressure against the se
(3, p 292)
b) **ZZ 42**, consisted of a bakelite cylindric
containing a percussion cap, a striker retaini
and a striker spring held under tension by
wire loop. Pulling on the trip wire attache
release pin withdrew the pin thus allowing t
to hit the percussion cap. The igniter coul
operated by attaching a trip wire under stro
to the end hole in the striker and carefully
the release pin. This igniter was designed f

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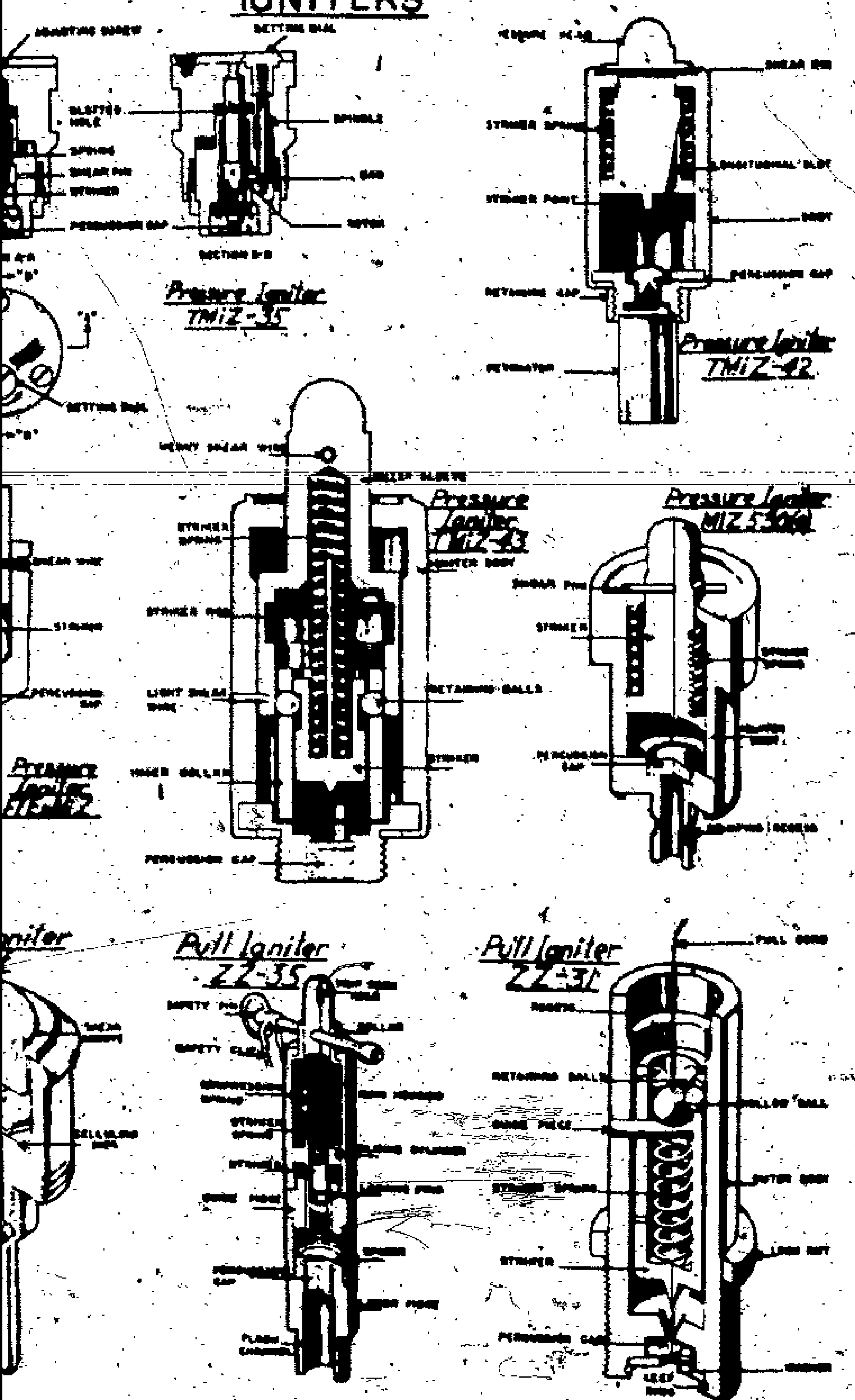

striker against the percussion cap etc. The igniter was designed for use as a push igniter in improvised mines, or as an impact igniter for HE charges when used in an assault (3, p 298)

g) SMiZ 35 designed for use in Schützenmine, also called Bounding Mine (3, p 299)

h) TMiZ 35 (Tellerminenzünder 35), used in T-Mi 35 (3, p 301)

i) TMiZ 42, used TMi 35 (steel), TMi 42 and TMi 43, also called Pilzmine (Mushroom Mine) (3, p 303)

j) TMi 43, used as above (3, p 304)

k) FlEsMiZ used in Flascheneismine 42 (Antipersonnel glass bottle mine) (3, p 307)

l) MiZ 530(e), an igniter manufd in Germany for use in the British Antitank Mine 530 (3, p 305)

m) **Topfminenzünder** (Pot Mine Fuze) consisted of a hollow, cylindrical, glass body into which fitted a solid pressure head. Inside the cylinder were located two glass ampoules containing liquids which on mixing ignited the explosive train of the Pot Mine (Topfmine). A pressure of about 150 kg was sufficient to crush the ampoules (3, p 306)

C. Pull Type (Zugzünder).

a) ZZ 35, used in S-Mines, some prepared charges, booby traps employing trip wires) and for booby trapping of Teller mines (1, p 83.04 & 3, p 288)

b) Type 31 designed for use in antipersonnel mines and booby traps (3, p 289)

D. Pull and Shear Type (Zug- und Zerschneidezünder), also called **Pull and Tension Wire Igniter**, such as **ZuZZ 35**, consisted of a brass case containing a percussion cap, striker, striker spring (located inside a sliding cylinder and held on top by a plunger), an outer compression spring, a retaining (locking) pin and a safety pin. The top of plunger was connected to a trip wire held under tension. The igniter was fired either by pulling on the trip wire or by loosening (cutting or breaking) it. In the first case the trip wire caused the plunger to be pulled upward against the resistance of the outer spring. This permitted the two locking pins to be forced outward into the upper open space, thus freeing the striker. In the second case, breaking or cutting of the trip wire allowed the outer (compression) spring to force the sliding cylinder downwards. This permitted the locking pins to be forced outwards into the lower open space, thus freeing the striker. This igniter was used with S-mines, booby traps and prepared charges. (1, p 83.05 & 3, p 293)

E. Percussion Type (Schlagzünder oder Aufschlagzünder).

a) Schlagzünder 35 was a modified version of ZuZZ 35; uses not indicated (2, p 163)

b) Safety Fuse Igniter consisted of a cylindrical brass body containing a spring-loaded striker held in position by a friction fit of the Z type with a cap to which was attached a large steel ring. A strong pull on the ring detached the striker release plate from the striker thus permitting the spring to drive the striker into the percussion cap. The device was used to ignite a safety fuse (3, p 287)

c) **Type 2 (Pull Percussion) Igniter** was designed for use with the new type parachute antipersonnel bomb but was suitable for use with mines and booby traps. For operation, a sharp pull on the split ring caused the striker release plate to be drawn from the igniter body, thus releasing the striker spring, which was under tension (3, p 288)

d) Aufschlagzünder 355(h) for use in Dutch Antitank Mine 355 (2, p 164)

F. Pull and Pressure Type (Zug- und Druckzünder).

a) ZDZ 29 Igniter, used in the assembly of antitank, antivehicle or antipersonnel mines, could be operated either by pull on a trip wire attached to the loop of the pull pin, or by pressure against the setting head (3, p 292)

b) **ZZ 42**, consisted of a bakelite cylindrical casing containing a percussion cap, a striker retaining washer and a striker spring held under tension by the trip wire loop. Pulling on the trip wire attached to the release pin withdrew the pin thus allowing the striker to hit the percussion cap. The igniter could also be operated by attaching a trip wire under strong tension to the end hole in the striker and carefully removing the release pin. This igniter was designed for use in Stock mines and booby traps (1, p 83.06 & 3, p 295). Note: This igniter is listed in Ref 1 as "Pull" Type, whereas Ref 3 lists it as a "Pressure and Pull" Type

c) **SMiZ 44**, developed for use in S-Mine 44 and in some improvised mines, consisted of a steel cylindrical case containing a percussion cap, striker and spring. The striker was retained in a cocked position by two winged detents, to which two trip wires were attached. The detents were held in position by a retaining collar (mounted on the case) and by a safety pin. After arming the device (by withdrawing the safety pin), a pressure of 21 lb or a pull of 14 lb on the winged detents opened them sufficiently to release the striker (3, p 294)

G. Electric Type (Elektrischer Zünder), **ESMiZ 40** consisted of an ebonite, Gooch funnel-shaped housing, provided with a spike and containing a striker, a spring, a release plunger, a glass ampoule and two electrodes. In order to enlarge the igniter area for one mine, usually an S-Mine, eighteen of these igniters were wired up in parallel, nine igniters in each chain, and spiked in the ground around the mine. The chains were connected by means of wires to two plugs fitted into sockets of the electric bridge (aluminum wire), surrounded with a flash composition and screwed on to the mine. Pressure on the prongs of any of the 18 igniters, depressed the release plunger and liberated the two steel locking balls in the head of the striker. This caused the spring to drive the striker into the glass ampoule. The liberated electrolyte set up a current between the electrodes and the current was transmitted to the bridge wire. The heat of the wire fired the flash composition and finally exploded the HE charge of the mine (1, p 83.08 & 3, p 300-1)

H. Chemical Igniter (Chemischer Zünder).

a) **"Buck" Igniter** (Chemical Crush-Actuated Type), used with the antipersonnel "Pot" mine, consisted of a thin aluminum foil drum containing a glass ampoule with sulfuric acid surrounded with a white, powdered flash composition. The drum was secured by crimping to the brass base. When pressure was applied, the foil drum was dented, the ampoule broken and the acid mixed with the flash composition. This resulted in a chemical reaction which ignited the mixture and fired the detonator inserted in the mine (3, p 308-9)

b) **CMZ 41W** (Chemisch- mechanischer Zünder), used for delayed action demolitions consisted of a cylindrical bakelite housing containing a glass ampoule and other items shown on the drawing. When the ampoule was broken by pressure, the acid trickled through four perforations in the plastic lid into the reaction chamber (plastic cylinder) where the metal delay rod was located. As soon as the rod was sufficiently weakened and broke, the spring was released thus allowing the striker to hit the percussion cap. The resulting flash initiated the detonator, booster and the main HE charge (3, pp 313-14)

I. All Explosive Pressure Release Device, designed for use as a booby trap, was also suitable as an igniter in mines and other items. The body of the device consisted of two oblong blocks of molded explosive, (believed to be Nipolit), held together by two hollow brass bolts. The inner surfaces of both blocks were provided with molded recesses to retain the metal striker mechanisms. For operation, the device was placed under the object to be booby-trapped and as soon as the object was lifted the striker retaining arm of the device pivotted upwards, thus releasing the striker which fired the percussion cap, etc (3, p 307-8).

J. Long-Delay Clockwork Igniter.

a) 21-Day Delay Igniter was used in conjunction with large scale demolitions where a long delay was required (3, p 309)

b) **J-Feder 504** Igniter was used for the same purposes as the previous igniter, but it could be set for delays ranging from ½ hour to 21 days. The igniter consisted of a Büchner funnel-shaped aluminum or bakelite body, housing a clockwork mechanism in the upper (wide) portion and a striker assembly in the lower (narrow) portion. At the end of the predetermined delay period, the lever arm on the rotating control disc bore against the trip lever, causing it to disengage the striker. The striker, driven by a spring, exploded the percussion cap thus initiating the main HE charge (1, p 83.09 &

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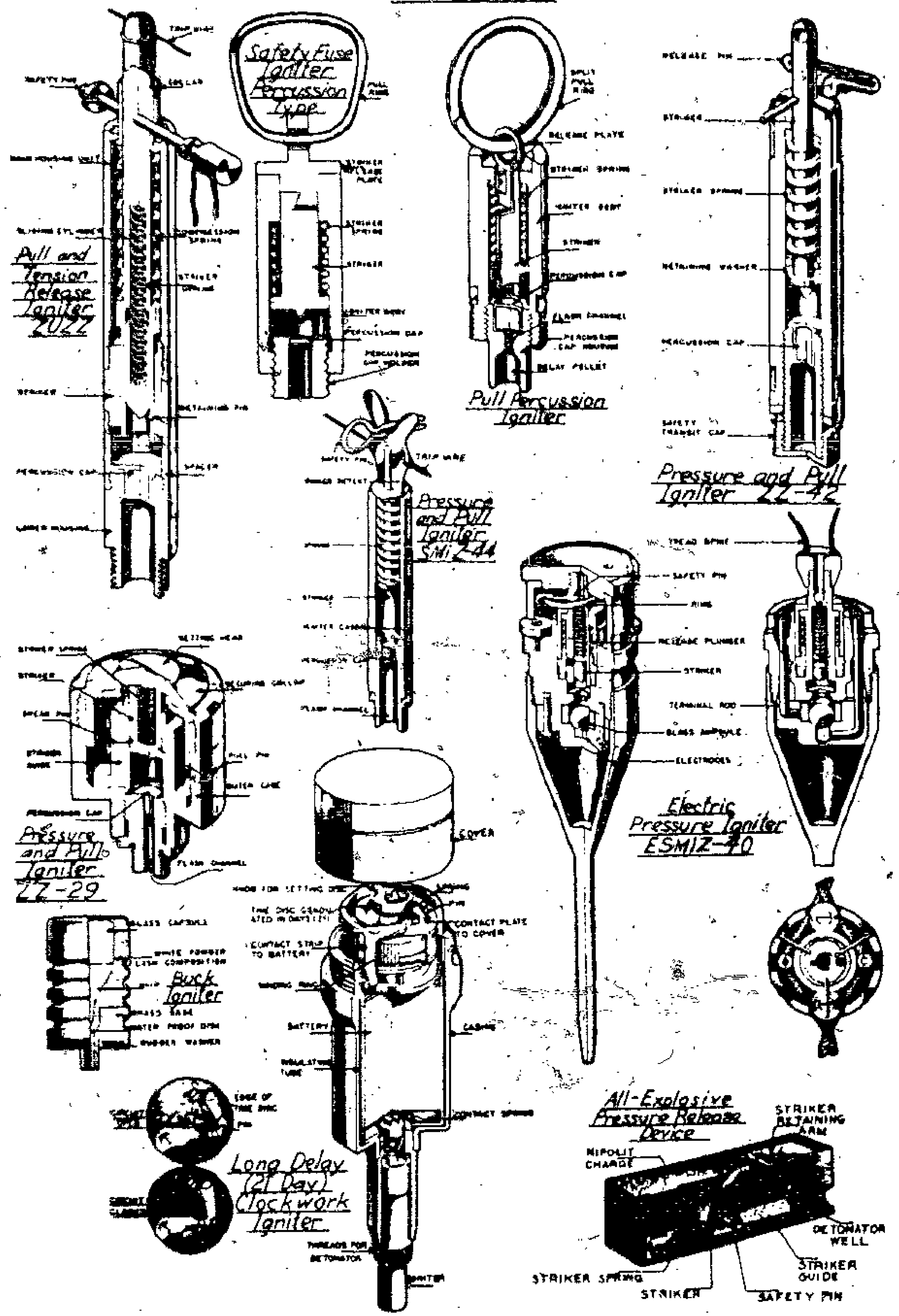

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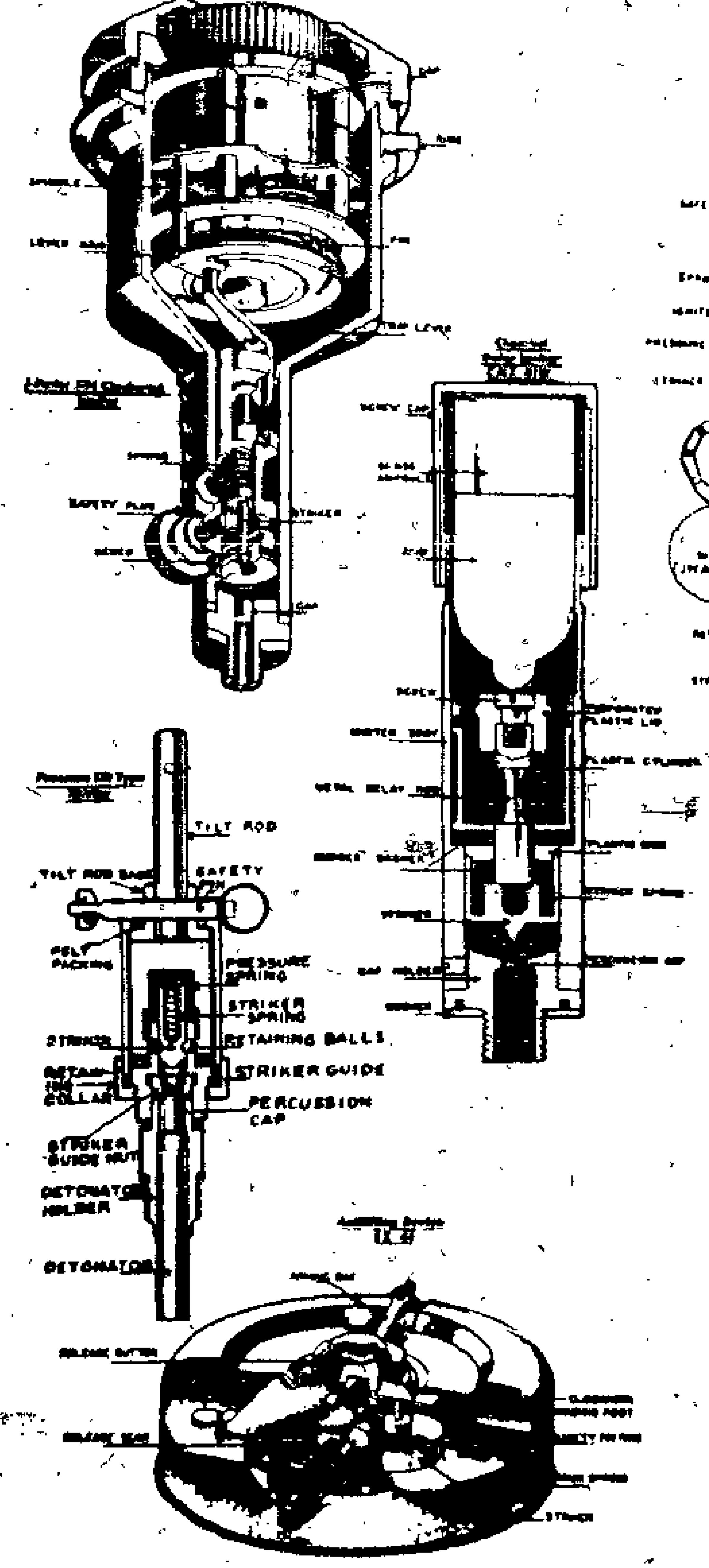

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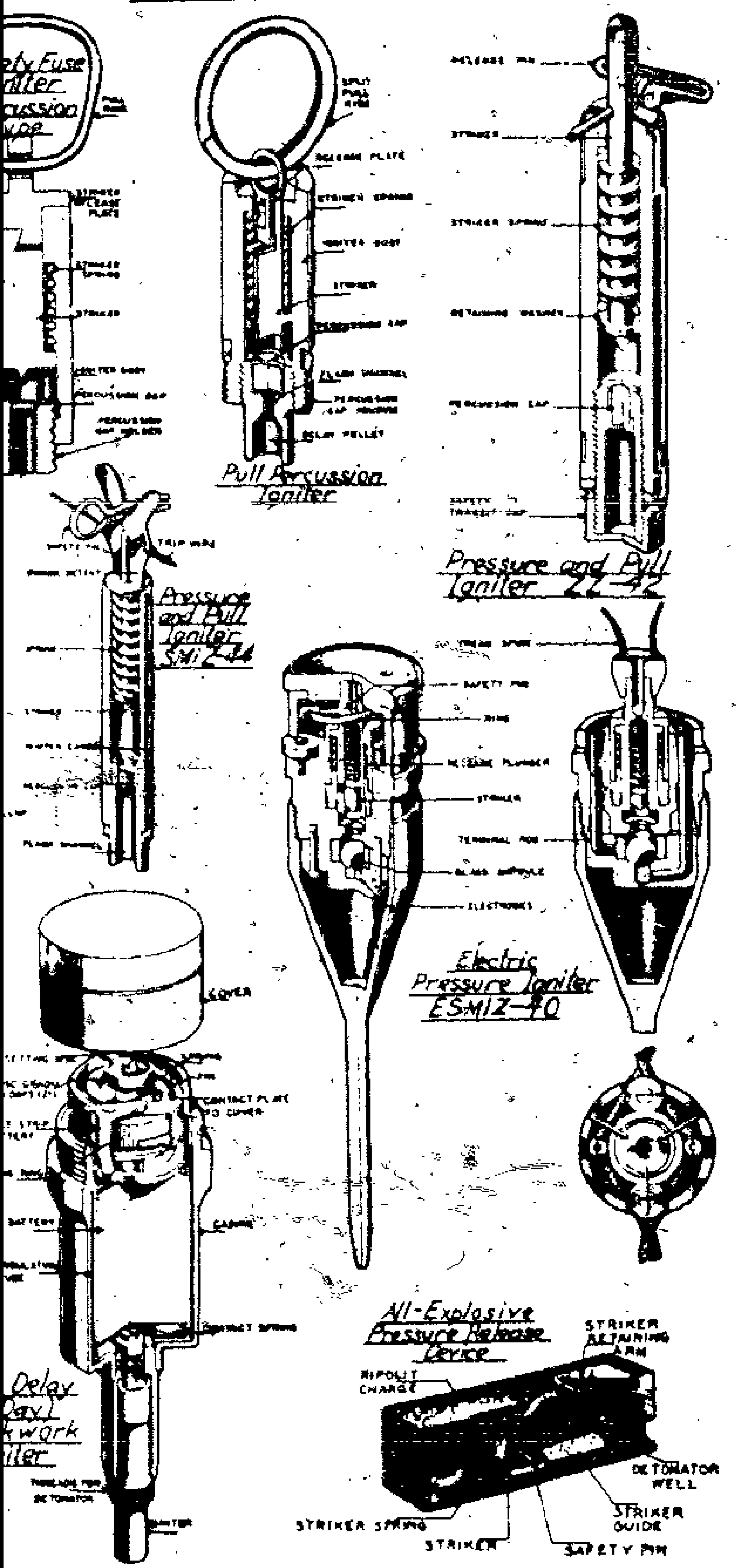

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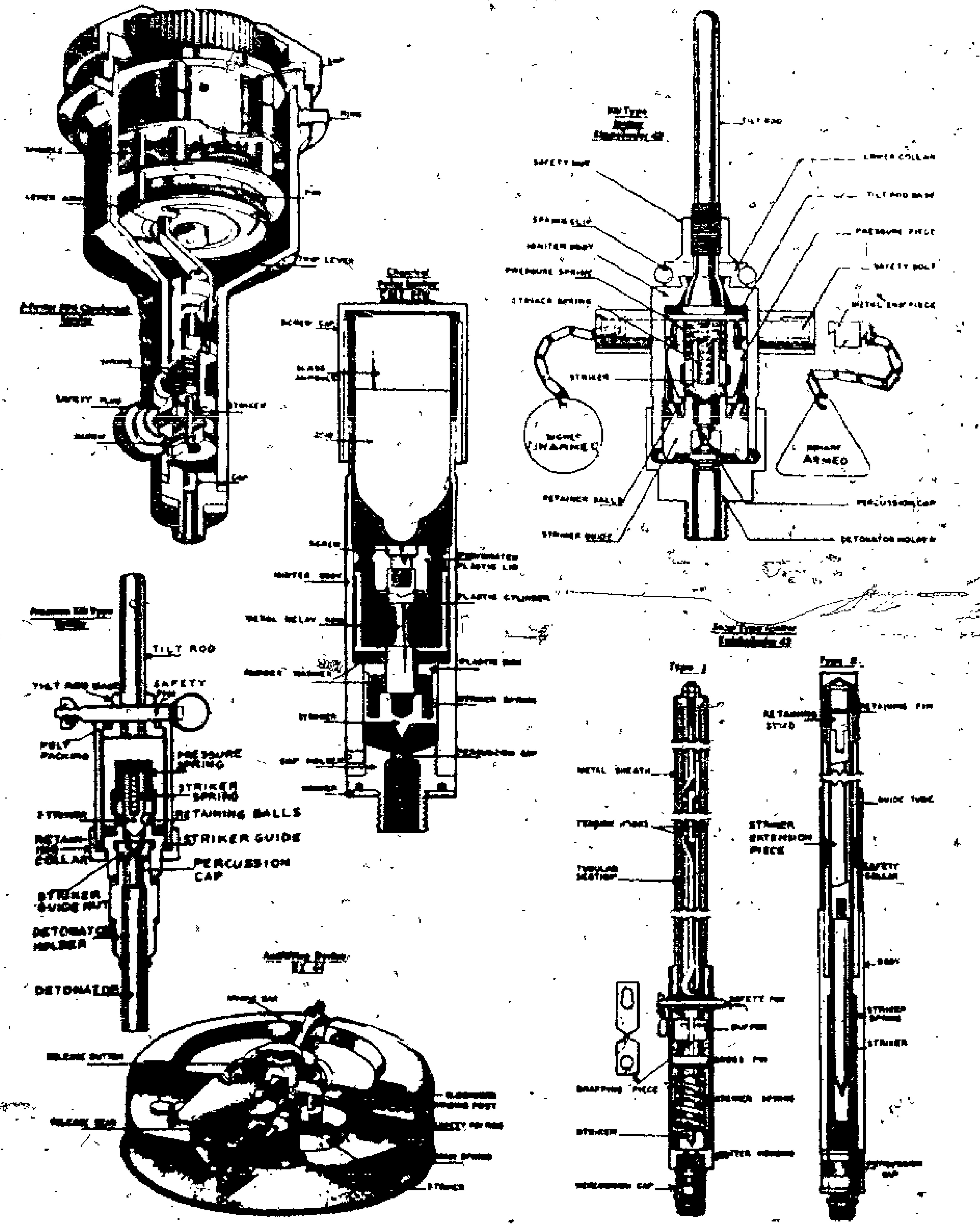

3, p 309)

K. Tilt-Type Igniter (Kippzünder).

a) KiZ 43 consisted of a tilt rod, and a 24-inch extension rod connected to a cylindrical body containing the striker mechanism and a percussion cap. Lateral pressure of 15 to 25 lb exerted in any direction on the tilt rod (or 1½ lb if the extension rod was used), caused the pressure piece to slide down. This allowed the retainer balls to slide outwards thus releasing the striker and its spring. The impact of the striker against the percussion cap set off the explosion train. This igniter was used in antitank and antipersonnel mines as well as in booby traps (1, p 83.076 & 3, pp 313-14)

b) KiZ 43 (New Type) retained the basic principles of KiZ 43 except that it had an entirely different safety device. It is described in Refs. 1, p 83.07e and 3, pp 315-16)

L. Antilifting Igniter (Entlastungszünder), such as EZ 44 consisted of the flat cylindrical upper casing, the base plate, the clockwork and striker mechanism and the explosive filling. After winding the clockwork mechanism, the device was placed under a mine or other object and the arming bar was pulled out by means of a cord or wire attached to the ring. When released, the clockwork, which ran only for 35-40 seconds gradually forced the safety pin ring outwards, thus withdrawing the safety pin. The striker was now retarded by means of the catch (sear), which in turn was held in place by the compressed spring of the release button. Removal of the weight from the release button of the igniter allowed the striker spring to force up the sear by means of the beveled stop, thus releasing the striker (2, p 163 & 3, pp 318-19)

M. Snap Igniter (Knickzünder).

a) KnZ 43/I consisted of a metallic cylindrical body and an extension composed of five tubular sections placed end to end and enclosed in a thin metal sheath. The extension housed five interconnected tension hooks, while the body contained the hollow striker transversely drilled above the striker pin, to accommodate the cross pin to which was assembled the snapping piece. The upper end of the snapping piece engaged the lower tension hook. This igniter was designed for use in mines lying between two tracks of enemy mines or for use in thick snow layers which prevent the functioning of the usual type igniters. The igniter operated (after removal of the safety pin) when the lateral pressure on the extension caused it to bend and to snap at the junctions. As a result of this the tension hooks exerted a pull on the snapping piece and the striker, thus breaking the snapping piece at its weak link. This action released the spring and allowed the striker to hit the percussion cap, thus exploding the mine (2, p 163 & 3, pp 316-17)

b) KnZ 43/II consisted of a metallic cylindrical body (housing the percussion cap, striker and spring) and a plastic tubular extension (housing the plastic striker extension, retaining stud and retaining pin). Lateral pressure on the igniter caused the tubular extension, as well as the brittle plastic striker extension, to snap. This released the striker and allowed it to impinge upon the percussion cap, and consequently to explode the mine. Uses of this igniter were the same as for KnZ 43/I (2, p 163 & 3, pp 317-38).

References:
1) Anon, Land Mines and Booby Traps, War Dept Field Manual FM 5-31 (1943)
2) Anon, Enemy War Materials Inventory List, Supreme Headquarters Allied Expeditionary Force (1945)
3) Anon, German Explosive Ordnance, Dept of the Army Tech Manual TM 9-1985-2 (1953)

Igniter Bags. According to F Englesburg, The Ordnance Sergeant, May 1944, p 321, the Germans employed igniter bags in all their artillery ammunition. The bags took the place of the large primers used by the U S Army in fixed and semi-fixed rounds of ammunition. The bags were either sewn to the base of the propelling charge or they were attached by means of a string. The standard substance employed in the bags during WW II was a finely grained nitrocellulose
(See also Ignition and under Propellants)

Igniter Compositions (Zündsätze). Igniter compositions used for propellants are listed under Propellants and the igniter compositions used for Tracers are listed under Tracers.

Ignition (Zündung). Ignition of a propellant in weapons up to 50 mm was accomplished in Germany by means of a primer, while larger weapons required a primer combined with an igniter containing black powder. Army weapons caliber 50 to 280 mm had an igniter contg 2 g of black powder, while the usual practice in the Navy was to use 1% of black powder per total weight of propellant. For guns larger than 280 mm an extension called Zündverstärker was used.

In addition to the primer extra igniters were sewn to both the front and rear of each section of the propelling charge.

For Flak and some Army guns the use of black powder was considered undesirable on account of its hygroscopicity and brittleness. It was reported that charges subjected to jolting contained broken up grains which caused too rapid ignition of the propellant. Much better results were obtained on replacing black powder by a charge called **Beiladung** which contained **NzManNP** (Nitrozellulose Manover Nudelpulver), a porous propellant prepared by leaching with water colloided NC contg some K nitrate. This propellant was also used in blank cartridges. Another replacement for straight black powder was **NSP** (Nitrozellulose-Schwarzpulver) which contained: NC 24.0, black powder 75.8 and diphenylamine 0.2%. This amount of NC was sufficient to bind the black powder together into hard grains.

In some cases, particularly at low loading densities, where the Beiladung did not give satisfactory ignition, a Grundladung (Base charge) of special flake propellant was used. The flake was of a size intermediate between the main charge of the tube propellant and that of the above NzManNP.

Practically all German cannon propelling charges consisted of long tubes and it was considered essential to ignite these at both ends. In order to ensure for the primer flash a clear passage to the front of the propelling charge, a thin-walled cordite tube of fairly large diameter was placed along the axis of each section of the charge.
Reference: H.H.M.Pike, CIOS Report 31-68 (1946), pp 7-8.

Ignition (Inflammation or Deflagration) Temperature Test [Entzündungs- (Entflammungs- oder Verpuffungs-) Temperaturprobe]. For description of the test see Kast-Metz, Chemische Untersuchung der Spreng- und Zündstoffe, Braunschweig, (1944), pp 224-6 and in the general section.

The ignition temperature of some explosive and pyrotechnic compositions was determined by F.Lenze, S S 27, 369-71 (1932).
(See also Flammability Test).

I G Wachs (IG Wax). During WW II, the I G Farbenindustrie developed several synthetic waxes some of which had higher melting points than natural waxes. These waxes were used for phlegmatizing explosives such as PETN and RDX.
Reference: A G Warth, The Chemistry and Technology of Waxes, Reinhold, N Y (1947), p 389.

Illuminating Compositions and Illuminating Bombs (Leuchtsätze und Leuchtbomben). See under Pyrotechnic Compositions and also in Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 124-9.

Incendiary Bomb. See under Bombe.

Incendiary Compositions and Incendiary Bombs. [Brandstoffe oder Brandsätze und Brandbomben]. According to Ref 2, p 18) most German incendiary projectiles consisted of an Elektron (such as MgAl or MgAl alloys) casing filled with thermite (such as Fe oxide 70-76 and

Al 30-24%). Other fillings were white phosphorus, oil or compositions such as: petroleum 87.7, polystyrene 11.8 and phosphorus 0.5% (Ref 4, p 56). One type of projectile was prepd by filling a container with pea-size lumps of dried paper pulp, followed by evacuation of air and running in molten white phosphorus (Ref 2, p 6). Another type, (B4), consisted of a steel outer case into which two tubes were inserted, the outer of celluloid and the inner of paper; the space in between these two tubes was filled with naphthalene, and the inner tube with thermite (Ref 1, p 2).

Most incendiary bombs resembled in appearance the ordinary HE bomb. They ranged in sizes from 1 kg magnesium bomb (B1E) to the 500 kg oil-filled bomb (Flam 500). Several incendiary bombs are listed under Bombe. The smaller types were usually carried in containers, whereas the larger bombs were carried in bomb racks like a similar size high explosive bomb. The 1 kg and 2 kg magnesium bombs often had a small antipersonnel charge incorporated in the bomb to discourage fire fighters. Some larger types also had a small explosive charge but this was for the purpose of scattering the incendiary mixture.
(See also Bombe Brandbombe, Flammbombe and Sprengbrand bombe).

Only few of the German shells listed in Ref 5 were incendiary. One of them, 50 mm HE-Inc-T (5 cm BrSpgrPatr 41 L'spur) was used in AA Gun, Flak 41 (p 397). Another was 88 mm Inc-Shrapnel (8.8 cm GrBrSchr Flak) used in AA guns Flak 18, 36 and 37 (p 448).

Some German incendiaries are described by Stettbacher (Ref 3).

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2) E.W.Bateman, CIOS Report 32-13 (1945), pp 6 & 18-19
3) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 124-9
4) TM 9-1985-2 (1953) 5) TM 9-1985-3 (1953).

Industrial Explosives. See Commercial Explosives.

Inertial Gravitation Guidance System or Ballistic Guidance System. See under Guidance Systems for Missiles.

Infra-Red Camouflage. See Infra-Rot Tarnung.

Infrared Guidance System. See under Guidance Systems for Missiles.

Infra-Rot Tarnung (Infra-Red Camouflage). Due to the fact that cloth covered objects could be readily detected by infra-red photography, even if camouflage coloring had been adopted, several dyes were developed by the IG Farben which minimized or even prevented such detection. The following types of dyes were considered to be worthy of consideration: Aniline Black, Diphenylamine Black, Carbon Black (when printed with organic binders) and Indanthrene Oliv GW Suprafix.
Reference: CIOS Report 25-18 (1945), pp 14-17.

Ingolin. The name given by Dr Walter to hydrogen peroxide of very high concentration (such as 85%). Ingolin can be used as a fuel or as a source of stored oxygen. As a fuel it produces superheated steam which can be used for driving either piston engines or turbines. As a source of oxygen, it was tried in submarines in order to allow them to use their main engines while submerged.
(See also Hydrogen Peroxide and T-Stoff).

Inhibiting Coating, intended to control the burning of rocket propellants and those for assisted take-off (ATO), was developed during WW II at the Duneberg Fabrik, D A G. Its composition was: polyvinyl acetate 25, lithophone 30, methylacrylate 5 and water 40%.
Reference: CIOS Report 29-24 (1945), p 5.

Initialexplosivstoff oder Initialsprengstoff (Initiating or Priming Explosive). See Priming and Initiating Composition.

Initialsatz (Initiating Composition). See Priming and Initiating Composition.

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section.
Reference: A.Stettba
(1933), p 134.

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gelatinizer 2.5% [
p 134].

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J-Feder-504. Cloc
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pp 309-13].

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Junkers Schmetterlin
developed during WW
Reference: A.Ducro
Paris (1947) pp 75-9

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Reference: R.J.Morle
pp 12-29.

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Infra-Red Camouflage. See Infra-Rot Tarnung.

Infrared Guidance System. See under Guidance Systems for Missiles.

Infra-Rot Tarnung (Infra-Red Camouflage). Due to the fact that cloth covered objects could be readily detected by infra-red photography, even if camouflage coloring had been adopted, several dyes were developed by the IG Farbenind which minimized or even prevented such detection. The following types of dyes were considered to be worthy of consideration: Aniline Black, Diphenylamine Black, Carbon Black (when printed with organic binders) and Indanthrene Oliv GW Suprafix.
Reference: CIOS Report 25-18 (1945), pp 14-17.

Ingolin. The name given by Dr Walter to hydrogen peroxide of very high concentration (such as 85%). Ingolin can be used as a fuel or as a source of stored oxygen. As a fuel it produces superheated steam which can be used for driving either piston engines or turbines. As a source of oxygen, it was tried in submarines in order to allow them to use their main engines while submerged.
(See also Hydrogen Peroxide and T-Stoff).

Inhibiting Coating, intended to control the burning of rocket propellants and those for assisted take-off (ATO), was developed during WW II at the Düneberg Fabrik, D A G. Its composition was: polyvinyl acetate 25, lithophone 30, methylacrylate 5 and water 40%.
Reference: CIOS Report 29-24 (1945), p 5.

Initialexplosivstoff oder Initialsprengstoff (Initiating or Priming Explosive). See Priming and Initiating Composition.

Initialsatz (Initiating Composition). See Priming and Initiating Composition.

Initiating Compositions (Initialexplosivstoffe). See Primary and Initiating Compositions.

Initiirvermögen (Zündkraft). The initiating property or power of primary or initiating explosives may be determined by loading an empty cap (such as the types used for No 8 detonators) with a weighed quantity of an explosive to be tested, compressing the sample and subjecting the loaded cap to one or both of the following tests: 1) Lead Plate Test or 2) Lead Block Compression Test.

These tests are used for the same purpose as the American Sand Test and Nail Test, described in the general section.
Reference: A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 134.

J (Pulver). One of the sporting propellants: guncotton 79; Am bichromate 14.0, K bichromate 3.0; moisture 1.5, and gelatinizer 2.5% [Brunswig, Das rauchlose Pulver (1926) p 134].

Jagdpulver (Hunting or Sporting Propellant). Two kinds of propellants were used in shotguns and sporting rifles, black powder and smokeless propellants. The first successful sporting smokeless propellant was "Schultze-Pulver". Other smokeless propellants used for sporting purposes were: Amberit, E C (Pulver), J (Pulver), Saxonia and Walsrode.
Reference: Brunswig, Das rauchlose Pulver (1926), p 134.

Jagd Tiger (Tank Destroyer Tiger). A self-propelled mount consisting of 128 mm A/T gun on PzKpfw VI (See under Panzer).

Jet Propulsion is briefly described in the general section. Some information on German jet units designed and manufactured by the Walter Werke, Kiel is given in CIOS Report 30-115 (1945).

Jet Propulsion Fuel. See under Sondertreibstoff.

J-Feder-504. Clockwork long-delay (¼ hour to 21 days) igniter used in demolition charges [TM 9-1985-2, (1953), pp 309-13].

Jonckit. See Yonckite in the Belgian section.

Junkers Schmetterling. One of the guided missiles (q v) developed during WW II.
Reference: A.Ducrocq, Les Armes Secrètes Allemandes. Paris (1947) pp 75-95.

Kalkammonsalpeter (Chalk-Ammonium Nitrate) was an intimate mixture in granular form of chalk and Am nitrate. It contained 20.5 to 21% N and was used as a fertilizer.
Reference: R.J.Morley, BIOS Final Rept 889, Item 22 (1946), pp 12-29.

Kaltspritzen (Cold-squirting). See Cold Extrusion in this and in the general section.

Kaltrecken, Kaltreckung (Cold Stretching). See Autofrettage in the general section.

Kampher (Camphor). See general section.

Kanone (K) (Cannon, Piece of Gun) Table 25a gives designations of German artillery weapons with their English equivalents:

Table 25a

Feldkanone	FK	Field Gun
Flugabwehrkanone	Flak	Antiaircraft gun
Gebirgshaubitze	GebH	Mountain howitzer
Gebirgskanone	GebK	Mountain gun
Kampfwagenkanone	KwK	Tank gun
Kanone (Eisenbahn)	K(E)	Railroad gun
Kanone ohne Rücklauf	KoR	Recoilless gun
leichte Feldhaubitze	lFH	Light field howitzer called by the British "gun-howitzer"
leichte Kanone oder leichtes Geschütz	lK (lG)	Light gun
leichtes Infanteriegeschütz	lIG (lJG)	Light infantry gun
Panzerabwehrkanone	Pak	Antitank gun
schwere Feldhaubitze	sFH	Heavy field howitzer
schwere Kanone oder schweres Geschütz	sK	Heavy gun
schweres Infanteriegeschütz	sIG (sJG)	Heavy infantry gun
(See also under Weapons)		

Kanone ohne Rücklauf. See Recoilless Guns.

"Karl" Mortar. See "Thor" and "Karl" Weapons.

Kartusche. See Cartridge.

KA-Salz The term assigned to RDX (Hexogen) prepd by the interaction of hexamine, Am nitrate, nitric acid and acetic anhydride. It is described in this section under Hexogen.

"Kaskade" Target Indicating Flare. See under Flare.

Kessen Explosives. Several explosive mixtures were proposed by W.Kessen of W A S A-G. One such explosive was patented in 1938 (Ref 1). It consisted of a regular blasting explosive plus an additional charge consisting of NG and/or nitroglycol mixed with a large amount of alkali bicarbonate. This mixture tended to produce inert gases and to absorb heat. If desired charges containing bicarbonate could be inserted between normal charges. These explosives were suitable for use in gaseous coal mines (See also Bikarbit and under Sheathed Explosives).

Another patent granted to the same person (Ref 2) dealt with the manufacture of moist Am nitrate explosives contg carbonaceous materials.

References:
1) W.Kessen and W A S A-G, Brit P 493 984, (1938) C A 33, 2719 (1939)
2) Ibid, Ger P 679,511 (1939); C A 33, 9647 (1939).

KH-Charge. The designation for a compressed charge consisting of 4-8 pellets of TNT wrapped in paper glued on the inside with an acid-free glue (such as dextrin, Vinnapas, etc). The wrapped charges were dried at 60-70° and then dipped in paraffin. They were used as bursting charges in Naval mines [See PB Rept No 925 (1945), p 48].

Kinetit (Kinetite). One of the oldest (1884) gelatinous explosives containing no NG gelatine. It consisted of K chlorate 75, antimony sulfide 3, nitrobenzene or nitrotoluene 21 and collodion cotton 1% [Naoúm, Nitroglycerin (1928), p 353].

King Tiger or Royal Tiger. See Königstiger, under Panzer.

Kippzünder 43 (Tilt-Type Igniter). See under Igniter.

Kitchen Salt Explosives. See Kochsalzsprengstoffe.

KIAZ 40. An impact-firing nose fuze used in some rockets, such as 8.6 cm R(L/4.5) and 8.6 cm R(L/5.5). [TM 9-1985-2 (1953), p 256].

KMA Block. One of the substitute explosives, See under Ersatzsprengstoffe.

Knallquecksilber (Mercury Fulminate) (M F) is described in the general section under Fulminates. German methods of preparation (from mercury, nitric acid and alcohol) are given in PB Rept No 95,613 (1947), section Q. M F was used by the Germans in some priming compositions. See also A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 95-96.

Knallsilber (Silver Fulminate). See general section under Fulminates and Stettbacher's book (1948) p 96.

Knallzündschnur (Detonating Fuse). See general section under Fuses.

Knetmaschine (Kneading Machine). An apparatus used for mixing solid ingredients in the presence of liquids. Several types were used in Germany such as the Columnar Type (Säulenknetmaschine) (Ref 2, pp 105, 106 and Ref 3, p 237), Werner-Pfleiderer Misch- und Knetmaschine (Ref 1, p 75 and Ref 3, p 227) and others.

References:
1) E. de B. Barnett, Explosives, Van Nostrand, N Y (1919)
2) P.Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927)
3) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig, (1933).

Knickzünder 43 (Snap Type Igniter). See under Igniter.

Kochsalzsprengstoffe (Kitchen Salt Explosives). Substitute explosive mixtures containing large amounts of Na chloride, which were used during WW II. Some of these mixtures are described under Ersatzsprengstoffe.

Kohlen-Carbonit
Kohlen-Koronit III — See under Kohlensprengstoffe.
Kohlen-Salit

Kohlensprengstoffe (Coal Explosives).
This was a group of explosives permitted for use in coal mines:

Kohlen-Carbonit. NG 25, K nitrate 34, Ba nitrate 1, flour 38.5, spent tan meal 1 and soda ash 0.5%; heat of explosion 506 kcal/kg, temp of explosion 1561°C, velocity of detonation 3160 m/sec, density 1.16 and Trauzl test value 235 cc (Ref 2, p 401 and Marshall, 2, p 492).

Kohlen-Koronit III NG 4, K chlorate 68, Na chloride 14, paraffin 8, nitronaphthalene 5 and wood meal 1%; oxygen balance -12% and Trauzl test value 195 cc (Ref 1).

Kohlen-Salit. NG (gelatinized) 12.5, meal 2.5, nitrocompounds 7.0, Am nitrate 41.0 and alkali chloride 37.0%; oxygen balance -2.6% and Trauzl test value 260 cc (Ref 2, p 441).

Kohlen-Westfalit I. NG 4.0, Am nitrate 83.0, K nitrate 7.0, Ba nitrate 2.0, meal 2.0 and TNT 2.0%; oxygen balance +16.4% and Trauzl test value 230 cc (Ref 2, p 435)

Kohlen-Westfalit IV. NG 3.2, Am nitrate 73.0, K nitrate 2.8, alkali chloride 15.0, meal 1.0, and DNT 5.0%; oxygen balance +8.8% and Trauzl test value 200 cc (Ref 2, p 435)

Kohlen-Westfalit V. NG 4.0, Am nitrate 83.0, K nitrate 8.0, Ba nitrate 2.0, potato meal 1.5 and Montan wax 1.5%; oxygen balance +13.5% and Trauzl test value 230 cc (Ref 2, p 435).

References:
1) P.Naoúm, Schiess- und Sprengstoffe, Dresden (1927), p 147
2) P.Naoúm, Nitroglycerin, etc, Baltimore (1928), pp 435 & 441.

Kohlen-Westfalit. See under Kohlensprengstoffe.

Kolax. An explosive of the carbonite type, such as: NG 25, K nitrate 26, Ba nitrate 5, wood meal 34, and starch 10%. There was also a Super-Kolax, an explosive used in England [Marshall 1 (1917), p 375].

Kolfit (Kolfite). A smokeless propellant patented in 1890 by H.Kolf of Bonn, which consisted of mixtures of nitrated cereal flours, moss, oil cakes, residues of factories manufacturing organic products such as starch, sugar, beer, alcohol, etc, with saltpeter previously saturated with nitrobenzene.

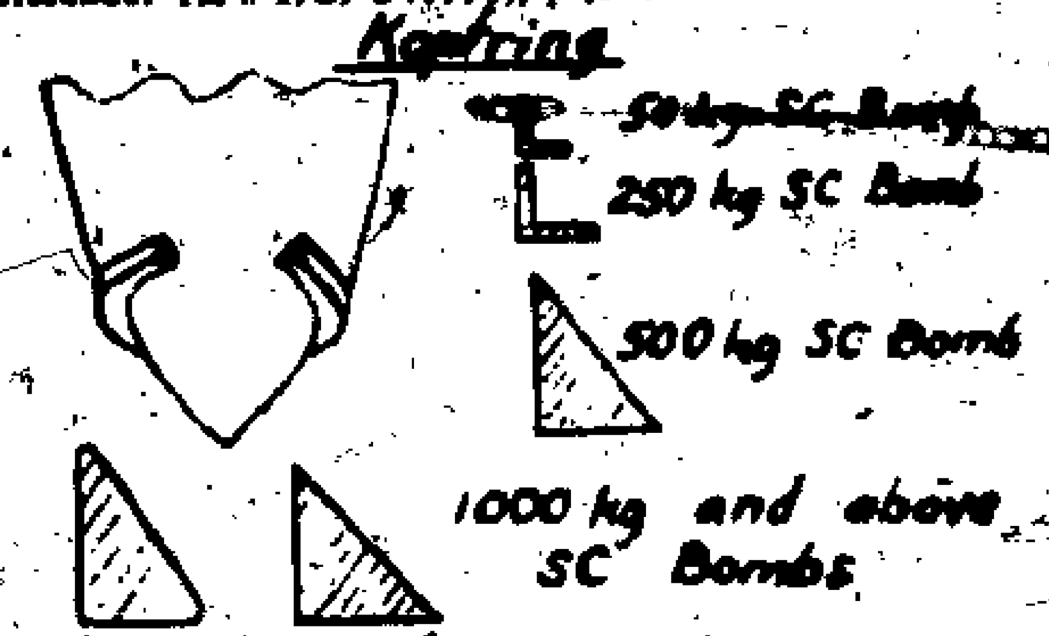
Reference: J.Daniel, Dictionnaire, Paris (1902), p 394.

Kontinuierliche Verfahren (Continuous Methods) of manufacture of explosives such as those of Schmid, Meissner and Biazzi were used in several German plants.

Some of these methods are briefly described under Nitroglycerin, Pentrit and Trinitrotoluol, as well as in the Belgian, Dutch, French, Swedish and Swiss sections.

References:
1) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), pp 174 & 333
2) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 60 & 97
3) A.Stettbacher, Pólvoras y Explosivos, Gili, Buenos Aires (1952).

Kopfring (Head Ring). When it was desired to avoid excessive penetration against land targets and to prevent ricochet against sea targets, rings were attached over the noses of bombs such as SC (HE cylindrical, general purpose) or some SD (A/P cylindrical, thick walled). (See also Anti-Ricochet Plates)
Reference: TM 9-1985-2 (1953), p 3.



Koronit V. On
during WW I: N
10, nitronaphth
und Sprengstoff
Note: Accordi
Koronit was

K Pulver. S

Kraftzahl (KZ)
of power (str
Lead Block T
errors is due
which is obse
ing gelatin, P
error, Neubne
expansion pro
the weight o
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obtain values
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the expansion
be determined
is called Kraf
Table 25

Substance
Blasting gelatin
NG
NC(13%)
P A
TNT
DNB

Note: It may
KZ values f
are determine
powerful exp
higher.

References:
1) R.Neubner,
2) A.Marshall,
3) A.Stettbach

"Kranich". A
guided missile
Reference: Th

Kreuzrohr (Cr

Krumbach Ni
propellant wi
in Flak. It
flash reducer,
31-62, p 5).

Krumbach (Pu
Double base
Nitrat Pulver
(CIOS 31-62, p

King Tiger or Royal Tiger. See Königstiger, under Panzer.

Kippzünder 43 (Tilt-Type Igniter). See under Igniter.

Kitchen Salt Explosives. See Kochsalzsprengstoffe.

KIAZ 40. An impact-firing nose-fuze used in some rockets, such as 8.6 cm R(L/4.5) and 8.6 cm R(L/5.5). [TM 9-1985-2 (1953), p 256].

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Kohlen-Salit. NG (gelatinized) 12.5, meal 2.5, nitrocompounds 7.0, Am nitrate 41.0 and alkali chloride 37.0%; oxygen balance -2.6% and Trauzl test value 260 cc (Ref 2, p 441).

Kohlen-Westfalit I. NG 4.0, Am nitrate 83.0, K nitrate 7.0, Ba nitrate 2.0, meal 2.0 and TNT 2.0%; oxygen balance +16.4% and Trauzl test value 230 cc (Ref 2, p 435)

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Kohlen-Westfalit V. NG 4.0, Am nitrate 83.0, K nitrate 8.0, Ba nitrate 2.0, potato meal 1.5 and Montan wax 1.5%; oxygen balance +13.5% and Trauzl test value 230 cc (Ref 2, p 435).

References:

1) P.Naoúm, Schiess- und Sprengstoffe, Dresden (1927), p 147

2) P.Naoúm, Nitroglycerin, etc, Baltimore (1928), pp 435 & 441.

Kohlen-Westfalit. See under Kohlensprengstoffe.

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Reference: J.Daniel, Dictionnaire, Paris (1902), p 394.

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Some of these methods are briefly described under Nitroglycerin, Pentrit and Trinitrotoluol, as well as in the Belgian, Dutch, French, Swedish and Swiss sections.

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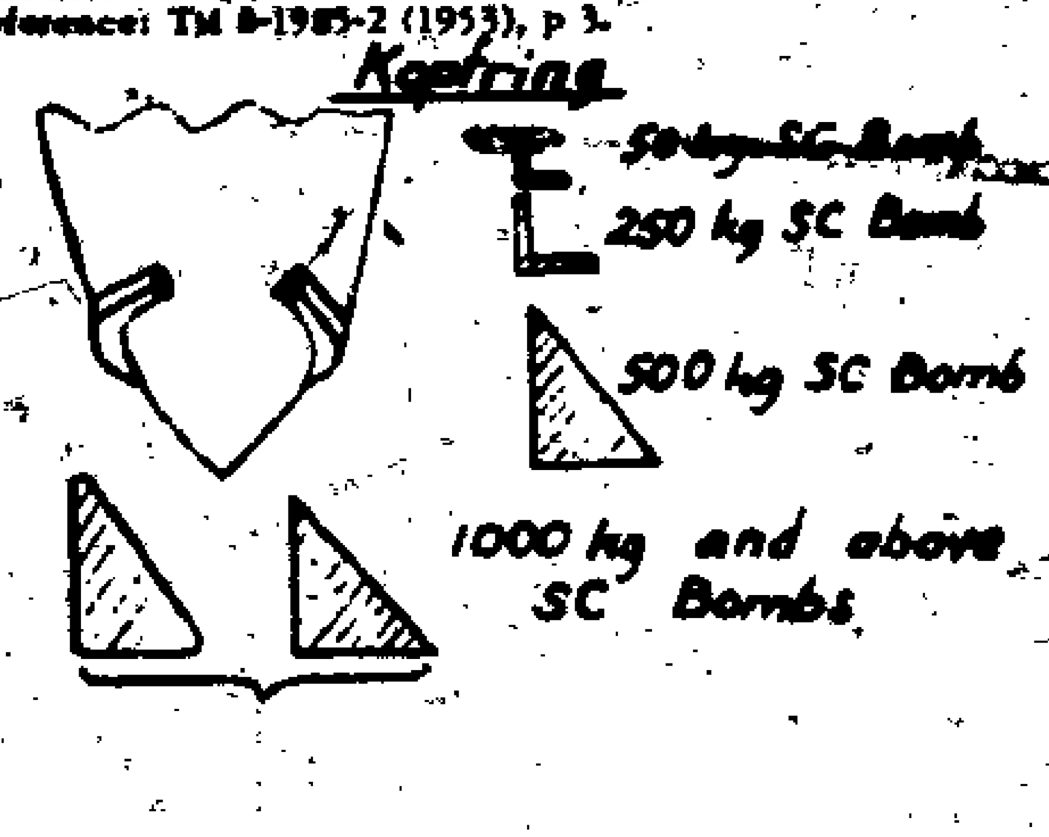
1) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), pp 174 & 333

2) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 60 & 97

3) A.Stettbacher, Pólvoras y Explosivos, Gili, Buenos Aires (1952).

Kopfring (Head Ring). When it was desired to avoid excessive penetration against land targets and to prevent ricochet against sea targets, rings were attached over the noses of bombs such as SC (HE cylindrical, general purpose) or some SD (A/P cylindrical, thick walled). (See also Anti-Ricochet Plates)
Reference: TM 9-1985-2 (1953), p 3.



Koronit V. One of the permissible explosives developed during WW I: NG 4, K chlorate 65, Na chloride 14, napthalene 10, nitronaphthalene 5 and wood meal 2% [Naoúm, Schiess- und Sprengstoffe, Dresden (1927), p 147].
Note: According to Marshall, v 3 (1932), p 112, the name Koronit was given in 1931 to Chloratit 1.

K Pulver. Same as G Pulver.

Kraftzahl (KZ) (Strength Number). In the usual determination of power (strength) of an explosion by the standard Trauzl Lead Block Test, (see general section) one of the principal errors is due to weakening of the walls of the cavity, which is observed with powerful explosives such as blasting gelatin, P A, TNT and NG. In order to eliminate this error, Neubner proposed that, instead of measuring the expansion produced by a standard weight of an explosive, the weight of explosive required to produce a standard expansion of 300 cc be determined. This may be done by firing several charges of different weights in order to obtain values below 300 cc and above it. After drawing a curve giving the relationship expansion vs weight of sample, the expansion in cc corresponding to a 10 g sample can be determined by interpolation. This calculated expansion is called Kraftzahl (strength number).

Table 25b lists KZs for some explosives

Table 25b

Substance	Trauzl Test Values observed by various investigators using a 10 g sample	KZ calculated by Neubner for a 10 g sample
Blasting gelatin	520 to 610cc	554cc
NG	515 to 600	540
NC(13%)	325 to 420	400
P A	300 to 365	385
TNT	285 to 300	350
DNB	250	311

Note: It may be concluded from the above values that the KZ values for highly powerful explosives are lower than are determined by the standard Trauzl test, while for less powerful explosives (such as TNT or DNB) the KZ is higher.

References:

1) R.Neubner, S S 23, 54 (1928)

2) A.Marshall, Explosives, v 3 (1932), p 143

3) A.Stettbacher, Spreng- und Schiesstoffe (1948), p 113.

"Kranich". An acoustic proximity fuze intended for some guided missiles as, for instance, Rocket X-4.
Reference: TM 9-1985-2 (1953), p 216.

Kreuzrohr (Cross Tube). See Distance Piece.

Krumbach Nitrat (KN) Pulver. Double-base DEGDN-NC propellant with a calorific value of 710-730 kcal/kg, used in Flak. It contained a small amount of K nitrate as a flash reducer, in lieu of K sulfate used in G Pulver (CIOS 31-62, p 5).

Krumbach (Pulver) ohne Nitrat aber mit Dinitrotoluol (KOD). Double base DEGDN-NC propellant similar to Krumbach Nitrat Pulver except that K nitrate was replaced by DNT (CIOS 31-62, p 5).

Krümmel Fabrik of Dynamit A.-G., located at Krümmel near Hamburg (See under War Plants) manufactured during WW II various explosives propellants etc and was engaged in research and development work for the Armed-Forces (Wehrmacht).

Following are some of the achievements of Krümmel Fabrik personnel:

A. **Pressing of explosives.** In loading ammunition (such as detonators, boosters and projectiles) one of the most important requirements is to maintain the same density of loading for each type of ammunition and for each kind of explosive. As a rule, the effectiveness of an explosive is higher at maximum density, but in some cases such high density is undersirable because it might cause dead-pressing (as in the case of mercuric fulminate) or cracking of pellets (as in the case of Np10, which is PETN densitized with 10 parts of wax). The exact required density of charge was obtained by weighing accurately each portion of the explosive and proceeding as described below:

In the preparation of pellets for boosters, the weighed masses of an explosive were transferred to one or two dozen molds placed in portable holders underneath a corresponding number of filling funnels fastened together in perforated plates. During filling, loss of explosive was carefully avoided so that the required density would be obtained. After ascertaining that each mold was properly filled, the foreman placed the holder with molds under a press located behind a strong wall and operated by remote control. Any spilled material was collected and blended with the next batch of explosive. The pressed pellets were removed and inspected for dimensions and density.

Note: Most of the pressing was done with phlegmatized PETN (usually with 10% wax), which was used to form charges for the 37mm tank shell, 70mm solid or hollow charges, 20mm high explosive charges and incendiary explosive charges, colored smoke charges, etc. The 20mm incendiary charge consisted of about 80 parts of PETN (previously phlegmatized with 10% wax) and 20 parts of aluminum. The charge weighed 6.6g. Some TNT charges were also compressed, such as those for shrapnel burster tubes, explosive charges for some mines, etc.

B. **Ejecting projectiles.** Special projectiles which ejected incendiary missiles on approaching a target (such as an airplane) were developed but did not come to the manufacturing stage. These projectiles contained several hollow steel cylinders, each of which was filled with an incendiary mixture consisting of Ba peroxide, aluminum and iron. A charge of about 15 g of HE was required for ejecting each cylinder from the projectile and to impart to it an acceleration of about 1000 m/sec. Each of these cylinders burned in flight and if one of them hit a combustible object (such as a gasoline tank of an airplane), a fire or even an explosion could take place.

C. **Space explosions with carbon dust.** Preliminary work was done on the development of a bomb which was charged with a HE and coal dust. It was presumed that the detonation of the HE would explode the coal dust which would become scattered in the air surrounding the bomb, thus producing a high pressure (blast) effect at distances as far as 50 m from the center of the explosion. These bombs were intended for antiaircraft purposes. Experiments with coal dust were not successful, but Al or Mg dusts could be exploded in air when charged into a bomb mixed with a powerful HE and a small amount of chlorate. The research was not completed (See also Explosive Powered Vortices)

D. **Shaped charges.** See under Hohlladung

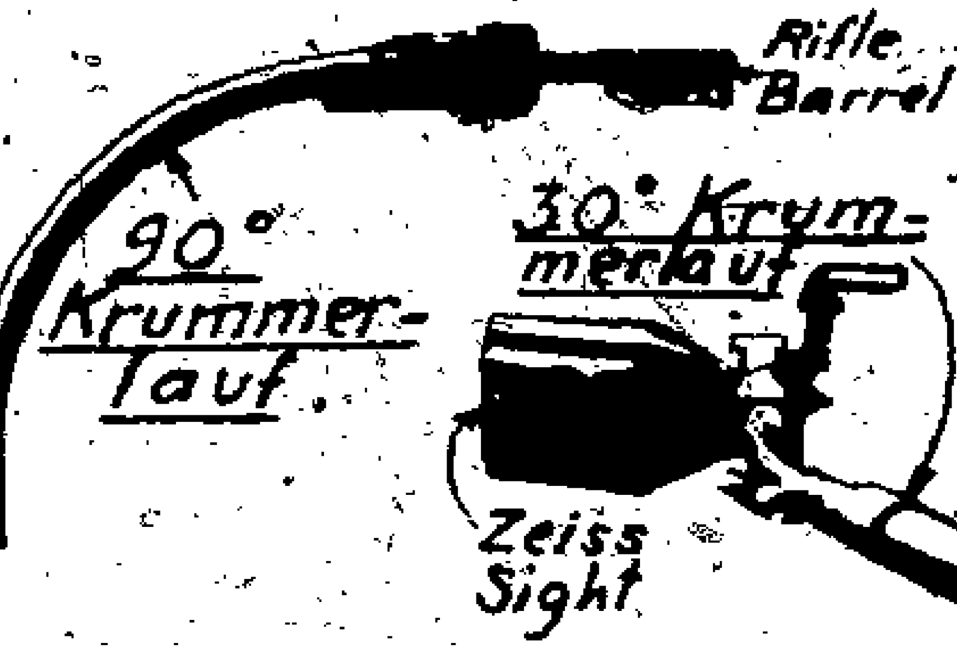
E. **Flash reducing compounds** are described separately

F. **Structural explosives** are described separately.

Reference:
O.W. Stickland et al, General Survey of Explosives Plants, PB Rept No 925 (1945), Appendix 3 and Appendix 7.

Krummerlauf (Bent Barrel). A special bent-barrel attachment to a gun, invented by Col H. Schade of the Rheinmetall-Borsig Co, was available in two degrees of bend 90° and 30°. The first type changed the course of the bullet by a right angle and was known as the "Around the Corner Gun". It was intended to be used (in a ball joint) in the parts of the tank where it was necessary to protect the blind spots. The barrel was 18¼" long and about 1" in diameter. Its range was short and its fire was not accurate. It was fired at random because no sight was provided. The second type (30° bent) barrel could be attached by means of an adapter to one of the service rifles, such as the MP 44. It was provided with a prismatic optical sight (designed by Zeiss), which permitted fairly accurate shooting from behind a solid barricade. The operator of this equipment was thus protected from enemy fire. Both barrels used the 7.92 mm short (kurz) bottle-necked cartridge.

A more detailed description may be found in the book: Ph.B. Sharpe, The Rifle in America, Funk & Wagnalls Co, N Y, pp 638-40.



Krupp Maus (Krupp Mouse). See Experimental Tanks, under Panzer.

K-Salz. The term assigned to Hexogen (RDX) prepd from hexamine, ammonium nitrate and nitric acid (See under Hexogen in this section).

K_3-Stoff (K_3 Substance). A highly dispersed silica SiO_2 prepd by a special process. It was used during WW II in some Tetan Explosives [PBL Rept 85,160 (1946), p 3].

"**Kugelblitz**" (Bullet Lightning). An armored AA vehicle having a 30 mm twin gun mounted on a PzKpfw III (See under Panzer).

Kugel K-"Kurt" Apparatus. See item 11 under Bombe.

Kugeltreibmine 43 (KTrMi 41). A spherical floating mine weighing about 90 lb [Recognition Handbook for German Ammunition, Sup Hqs AEF (1945), p 241].

Kumulative Zündung. See Gegenläufige Zündung.

"**Kurt**" **Apparatus** (SB 400 Skip Bomb). See item 11 under Bombe.

Kurzschlusszünder (Short-Circuit Primer or Igniter). Several varieties, such as the Schäffler, Reinecke and Eindrahtzünder (one-wire primer) are described in Beyling-Drekpof, (1936), pp 216-222.

Lagerbeständigkeit oder Haltbarkeit (Stability in Storage or Keeping Quality). Several tests are described in Kast-Metz, Chemische Untersuchung (1944), pp 258-61, 320-27 344-45 and 460-61 (See also Warmlagerversuche).

LANDMINEN (Land Mines). A great variety of land mines were used during WW II by the Germans as can be seen from the following information taken from References 1 - 6:

1) Antitank Mine, called **Pappmine**, because it was made of special cardboard "Pappe", a non-metallic substance used to prevent the detection of the mine by electric detectors. Pressure on the "pressure plate" forced it down onto the head of a glass igniter, containing a central glass tube filled with a reddish ignition mixture of unknown composition. Crushing of the central tube produced a flash which passed to the detonator which exploded the mine. Pressure on the cardboard of the mine would not set it off. The mine was filled with 11 lb of TNT (Ref 6, p 261)
2) Antitank Mine, called **Panzerschnellmine**, consisted of a wooden box filled with picric acid (13.2 lb). There were two types, A and B, very similar in construction. The booster in both cases consisted of 200 g of an explosive such as PETN/wax. Type A was actuated by pressure on the box lid, causing the shearing of two ½-inch wooden dowels and pressing out the link pin of the ZZ 42 igniter. Type B was actuated by pressure on the box lid shearing ½-inch wooden dowels and exerting pressure on the heads of two Buck igniters (Ref 5, pp 94-5 and 6, p 262)
3) Magnetic Antitank Mine, called **Panzerhandmine 3** was designed to be placed on enemy tanks or other targets to which it adhered by means of magnets (See under Hafthohlladung)
4) Wooden Box Antitank Mine (**Holzmine 42**) was filled with 50/50 Amatol (18 lb). The mine was in the shape of a flat box. A pressure of 200 lb or more on the pressure block sheared the dowels and forced down the shear flange, which in turn pushed out the pin in the igniter ZZ 42. The freed striker, driven by a spring, set off a percussion cap, detonator, booster and main charge (Ref 4, pp 81.06a-e and 6, pp 263-4)
5) Antitank Mine, called **Sprengriegelmine** (Explosive Bar Mine) was of two varieties: Riegelmine 8 kg and Riegelmine 43. The latter variety, abbreviated as R-Mi 43 was in the form of a long, flat box and consisted of a sheet steel tray, an encased charge of 8.8 lb of TNT and a lid which fitted over the tray and acted as a pressure plate. The mine could be fired in one of five ways: a) Pressure on the lid sufficient to shear one or two shear wires; b) Functioning of an antilifting or trip wire; c) Electrically, by remote control; d) Booby-trapping the mine, as by attaching a trip wire to the lid; e) Reversing of one igniter ZZ 42 with its wings below the end pressure plate so that the mine could function in case an attempt was made to lift the charge of TNT from the tray. Total weight of mine was 20.5 lb (Ref 6, pp 264-5 & 272-3)
6) Heavy Antitank Mine (**Schwere Panzermine**) was made of cast iron and contained 37 lb of Picric Acid, Total weight was 500 lb. The mine was fired by a downward pressure exerted on the cover plate, which pivoted on the trunnions. This pressure compressed the main pressure igniter, which fired the charge. The mine was used for road blocks where action had been static for a period of time. Total weight was 300 lb (Ref 6, pp 265-7)
7) Antitank Mines, called **Tellerminen** (Plate-Shaped Mines), were of the following varieties: Tellermine 35, Tellermine 42, Tellermine 43 and Tellermine 29. Type 35 mine existed in two varieties, both of them made of steel and similar in construction. The 2nd variety, designated Tellermine 35 (Steel) had the pressure plate made of corrugated steel for more strength. They were filled, respectively, with 11 a[...] TNT. Both mines operated by pressure o[...] 200 lb or more. This depressed the igniter [...] sheared the pin holding the striker in the coc[...] etc. The Tellermine 42 was similar to th[...] that the pressure plate was smaller and did [...] the entire upper surface. Pressure of 250-[...] forced the pressure cap down. This com[...] heavy pressure plate spring and detonate[...] The TMi 43 (also called **Pilzmine** (Mushroom[...] similar to the TMi 42 except that the pressu[...] solid, i e there was no threaded hole for the [...] the igniter and no screw cap. The walls of th[...] shaped plate were thin and there was no [...] under the pressure. Like Tellermine 42 i[...] with 12 lb of TNT. The mine operated [...] pressure on the mushroom lid. This crush[...] walls and forced the head of the striker [...] igniting the mine. Tellermine 29 also des[...] was a light antitank mine constructed of [...] It was filled with 10 lb of TNT. The top [...] domed and had three adapters for ZDZ[...] The mine was exploded when sufficient [...] applied to one or several igniters. Total [...] mines were as follows TMi 35 20 lb, T[...] 21 lb, TMi 42 20 lb, TMi 43 18 lb and TMi [...] (Ref 1 & 2; Ref 4, pp 81.01-81.04 & 6, pp 26[...]

Note: According to Ref 2, the TMi 43 (Pi[...] during WW II at Picatinny Arsenal contained a[...] charge 10.87 lb of Amatol, consisting of A[...] and TNT 56%. The booster pellets consisted [...] PETN and 12% Montan wax.

8) Pot-Shaped Antitank Mine (**Topfmine A**), [...] Saucepan Mine, consisted of a plastic [...] with 12.5 lb of TNT or 50/50 Amatol. [...] of the mine was 20 lb. Under a load of at [...] (330 lb) the pressure plate sheared along [...] and thus came to rest on the head of the [...] in turn moved down and crushed two small [...] located inside the igniter body. The capsu[...] chemicals* which on mixing produced a [...] in turn set off the detonator and then th[...] of the mine (Ref 4, p 81.08; 5, pp 26-9 and [...]
9) **Clay Mines** were of two types: Antitank and [...] The Antitank Mine consisted of a baked [...] in diameter and 10" high with a wall [...] with a clay pressure lid about 5" thick. [...] sides of the top of the pot were two round [...] housed ZZ 42 igniters. Two hollow pas[...] down inside each bulge carried the lengt[...] taneous fuse connecting ZZ 42 igniters [...] charges located at the bottom of the main [...] as Picric Acid. Pressure on the lid pu[...] out of the igniters, thus releasing the [...] strikers, etc. The Antipersonnel Clay M[...] of a round clay pot 8" in diameter and 3" [...] wall [...]" thick, provided with a cover. [...] Picric Acid was detonated by means of [...] train, consisting of four ZZ 42 igniters, a [...] a booster, when a pressure equal to [...] man's weight was applied to the lid (Ref[...]
10) Antipersonnel or Antitank Aluminum Mi[...] with Cheddite (7 lb) and had a TNT boo[...] and the lid were of a flattened cylindrical [...] DZ 35 igniters together with No8 de[...] inserted in boosters located 120° apa[...] main explosive charge. Pressure on the [...] the center of lid set off one or more of th[...] and the mine went off. Total weight of [...] (Ref 6, pp 273-4)
11) Light Antitank Mine, (**PzMi** (Leichte [...] which could be converted to antiperson[...] sisted of two saucer-shaped, sheet metal [...] an O-shaped container for 5 lb of TNT [...] cover which served as a pressure plate. [...] were built into the mine and spaced [...] it. Pressure crushed the mine cover and [...] more igniter housings downward over [...] This action compressed the outer sp[...] the steel locking balls to be forced outw[...] recesses, releasing the striker, etc. [...] mine to antipersonnel use the bottom ig[...]

*Note. According to Dr Hans Walther, one cap[...] liquid K-Na alloy and the other ethyl nitrate [...]

Dynamit A-G, located at Krümmel under War Plants) manufactured during sives propellants etc and was engaged velopment work for the Armed-Forces

ome of the achievements of Krümmel

plosives. In loading ammunition (such boosters and projectiles) one of the requirements is to maintain the same g for each type of ammunition and for xplosive. As a rule, the effectiveness is higher at maximum density, but in h high density is undesirable because dead-pressing (as in the case of mer- or cracking of pellets (as in the case is PETN densitized with 10 parts of required density of charge was obtained urately each portion of the explosive s described below:

paration of pellets for boosters, the ses of an explosive were transferred dozen molds placed in portable holders orresponding number of filling funnels ther in perforated plates. During filling, losive was carefully avoided so that density would be obtained. After ascer- each mold was properly filled, the d the holder with molds under a press nd a strong wall and operated by l. Any spilled material was collected with the next batch of explosive. The lets were removed and inspected for d density.

pressing was done with phlegmatized h 10% wax), which was used to form m tank shell, 70mm solid or hollow h explosive charges and incendiary colored smoke charges, etc. The 20mm consisted of about 80 parts of PETN ized with 10% wax) and 20 parts of ge weighed 6.6g. Some TNT charges d, such as those for shrapnel burster ges for some mines, etc.

ectiles. Special projectiles which ejected les on approaching a target (such as e developed but did not come to the stage. These projectiles contained steel cylinders, each of which was incendiary mixture consisting of Ba um and iron. A charge of about 15 g uired for ejecting each cylinder from d to impart to it an acceleration of c. Each of these cylinders burned in of them hit a combustible object (such nk of an airplane) a fire or even an ake place.

osions with carbon dust. Preliminary on the development of a bomb which h a HE and coal dust. It was presumed ion of the HE would explode the coal d become scattered in the air surround- thus producing a high pressure (blast) ces as far as 50 m from the center of These bombs were intended for antiair- Experiments with coal dust were not successful, but Al or Mg dusts could be exploded in air when charged into a bomb mixed with a powerful HE and a small amount of chlorate. The research was not completed (See also Explosive Powered Vortices)

D. Shaped charges. See under Hohlladung

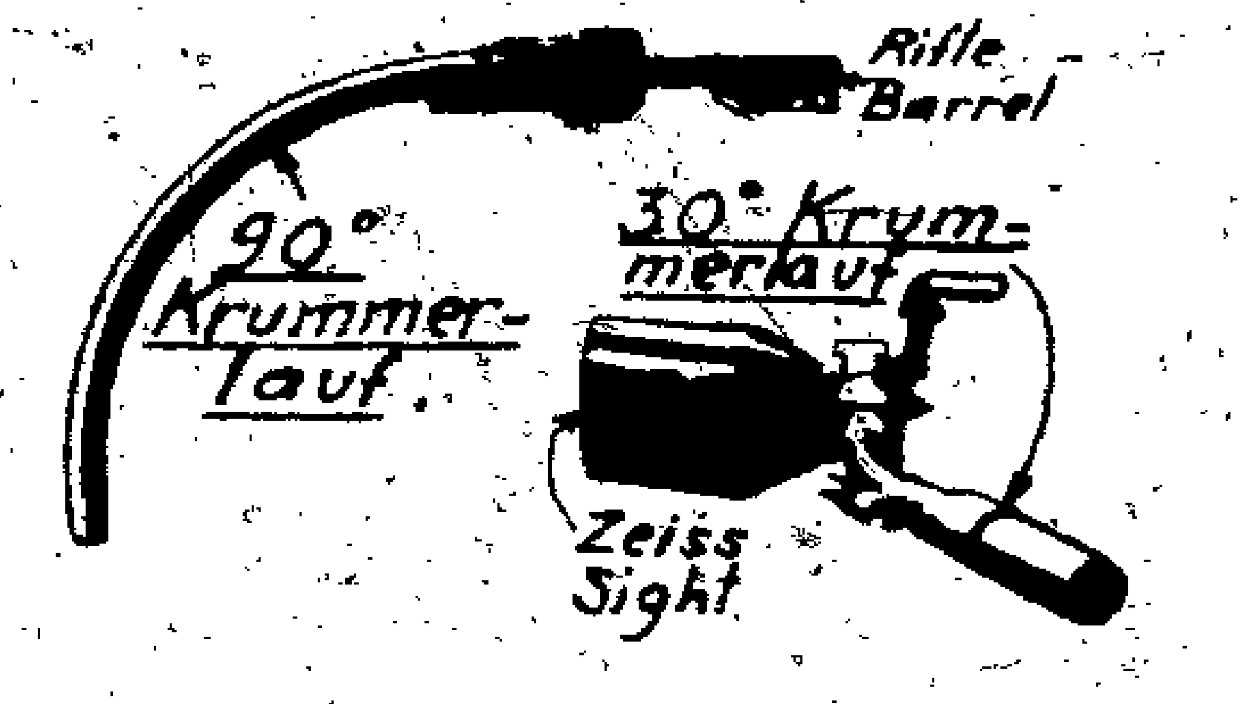
E. Flash reducing compounds are described separately

F. Structural explosives are described separately.

Reference:
O.W.Stickland et al, General Survey of Explosives Plants, PB Rept No 925 (1945), Appendix 3 and Appendix 7.

Krummerlauf (Bent Barrel). A special bent-barrel attachment to a gun, invented by Col H.Schade of the Rheinmetall-Borsig Co, was available in two degrees of bend 90° and 30°. The first type changed the course of the bullet by a right angle and was known as the "Around the Corner Gun". It was intended to be used (in a ball joint) in the parts of the tank where it was necessary to protect the blind spots. The barrel was 18¾" long and about 1" in diameter. Its range was short and its fire was not accurate. It was fired at random because no sight was provided. The second type (30° bent) barrel could be attached by means of an adapter to one of the service rifles, such as the MP 44. It was provided with a prismatic optical sight (designed by Zeiss), which permitted fairly accurate shooting from behind a solid barricade. The operator of this equipment was thus protected from enemy fire. Both barrels used the 7.92 mm short (kurz) bottle-necked cartridge.

A more detailed description may be found in the book: Ph.B.Sharpe, The Rifle in America, Funk & Wagnalls Co, N Y, pp 638-40.



Krupp Maus (Krupp Mouse). See Experimental Tanks, under Panzer.

K-Salz. The term assigned to Hexogen (RDX) prepd from hexamine, ammonium nitrate and nitric acid (See under Hexogen in this section).

K_3-Stoff (K_3-Substance). A highly dispersed silica SiO_2 prepd by a special process. It was used during WW II in some Tetan Explosives [PBL Rept 85,160 (1946), p 3].

"Kugelblitz" (Bullet Lightning). An armored AA vehicle having a 30 mm twin gun mounted on a PzKpfw III (See under Panzer).

Kugel K-"Kurt" Apparatus. See item 11 under Bombe.

Kugeltreibmine 41 (KTrMi 41). A spherical floating mine, weighing about 90 lb [Recognition Handbook for German Ammunition, Sup Hqs AEF (1945), p 241].

Kumulative Zündung. See Gegenläufige Zündung.

"Kurt" Apparatus (SB 400 Skip Bomb). See item 11 under Bombe.

Kurzschlusszünder (Short-Circuit Primer or Igniter). Several varieties, such as the Schäffler, Reinecke and Eindrahtzünder (one-wire primer) are described in Beyling-Drekpof, (1936), pp 216-222.

Lagerbeständigkeit oder Haltbarkeit (Stability in Storage or Keeping Quality). Several tests are described in Kast-Metz, Chemische Untersuchung (1944), pp 258-61, 320-27 344-45 and 460-61 (See also Warmlagerversuche).

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1) Antitank Mine, called **Pappmine**, because it was made of special cardboard "Pappe", a non-metallic substance used to prevent the detection of the mine by electric detectors. Pressure on the "pressure plate" forced it down onto the head of a glass igniter, containing a central glass tube filled with a reddish ignition mixture of unknown composition. Crushing of the central tube produced a flash which passed to the detonator which exploded the mine. Pressure on the cardboard of the mine would not set it off. The mine was filled with 11 lb of TNT (Ref 6, p 261)
2) Antitank Mine, called **Panzerschnellmine**, consisted of a wooden box filled with picric acid (13.2 lb). There were two types, A and B, very similar in construction. The booster in both cases consisted of 200 g of an explosive such as PETN/wax. Type A was actuated by pressure on the box lid, causing the shearing of two ½-inch wooden dowels and pressing out the link pin of the ZZ 42 igniter. Type B was actuated by pressure on the box lid shearing ½-inch wooden dowels and exerting pressure on the heads of two Buck igniters (Ref 5, pp 54-5 and 6, p 262)
3) Magnetic Antitank Mine, called **Panzerhandmine 3** was designed to be placed on enemy tanks or other targets to which it adhered by means of magnets (See under Haftbohlladung)
4) Wooden Box Antitank Mine (**Holzmine 42**) was filled with 50/50 Amatol (18 lb). The mine was in the shape of a flat box. A pressure of 200 lb or more on the pressure block sheared the dowels and forced down the shear flange, which in turn pushed out the pin in the igniter ZZ 42. The freed striker, driven by a spring, set off a percussion cap, detonator, booster and main charge (Ref 4, pp 81.06a-e and 6, pp 263-4)
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6) Heavy Antitank Mine (**Schwere Panzermine**) was made of cast iron and contained 37 lb of Picric Acid. Total weight was 300 lb. The mine was fired by a downward pressure exerted on the cover plate, which pivotted on the trunnions. This pressure compressed the main pressure igniter, which fired the charge. The mine was used for road blocks where action had been static for a period of time. Total weight was 300 lb (Ref 6, pp 265-7)
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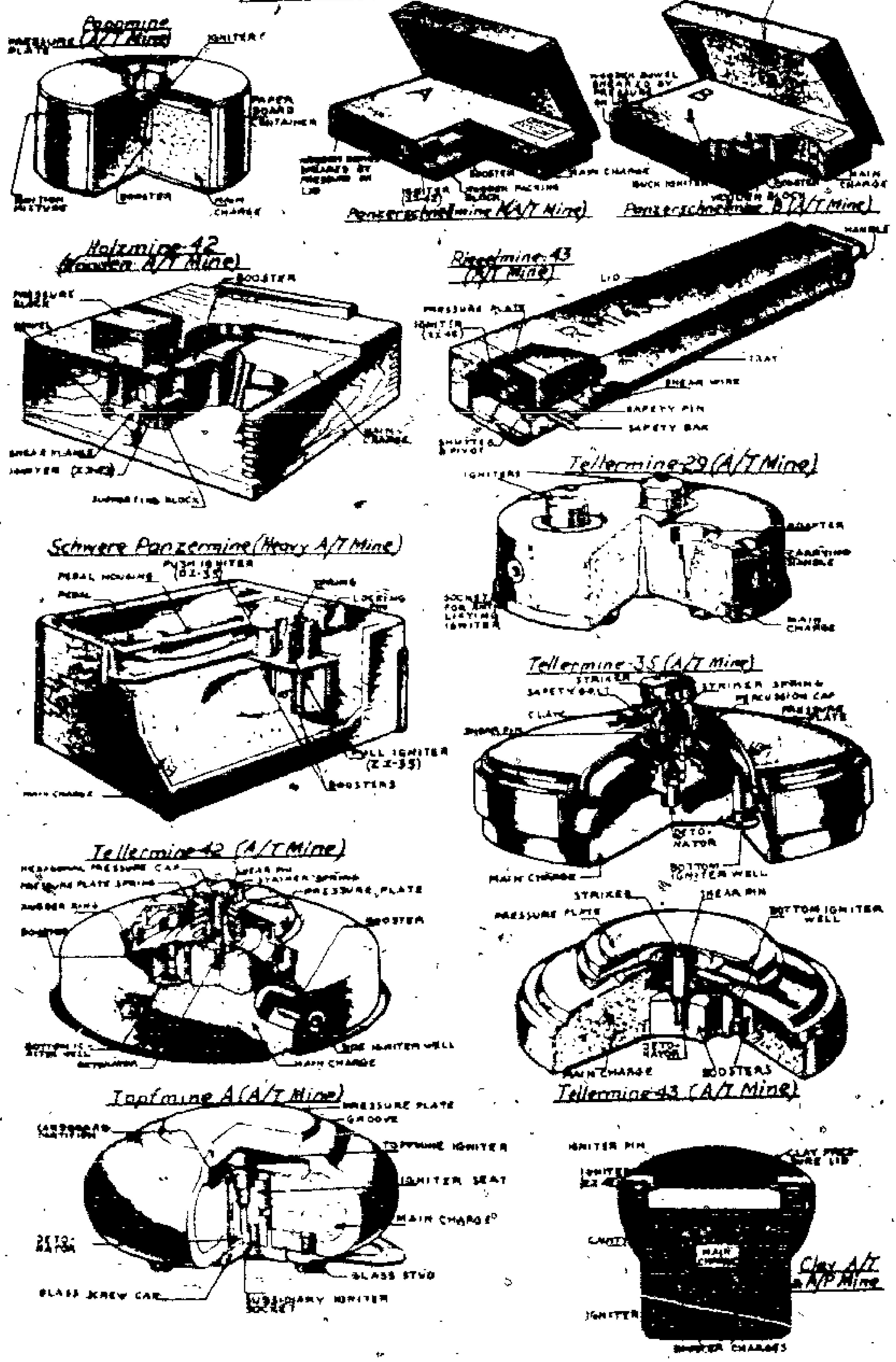
Note: According to Ref 2, the TMi 43 (Pilz) examined during WW II at Picatinny Arsenal contained as the burster charge 10.87 lb of Amatol, consisting of Am nitrate 44 and TNT 56%. The booster, pellets consisted of about 88% PETN and 12% Montan wax.

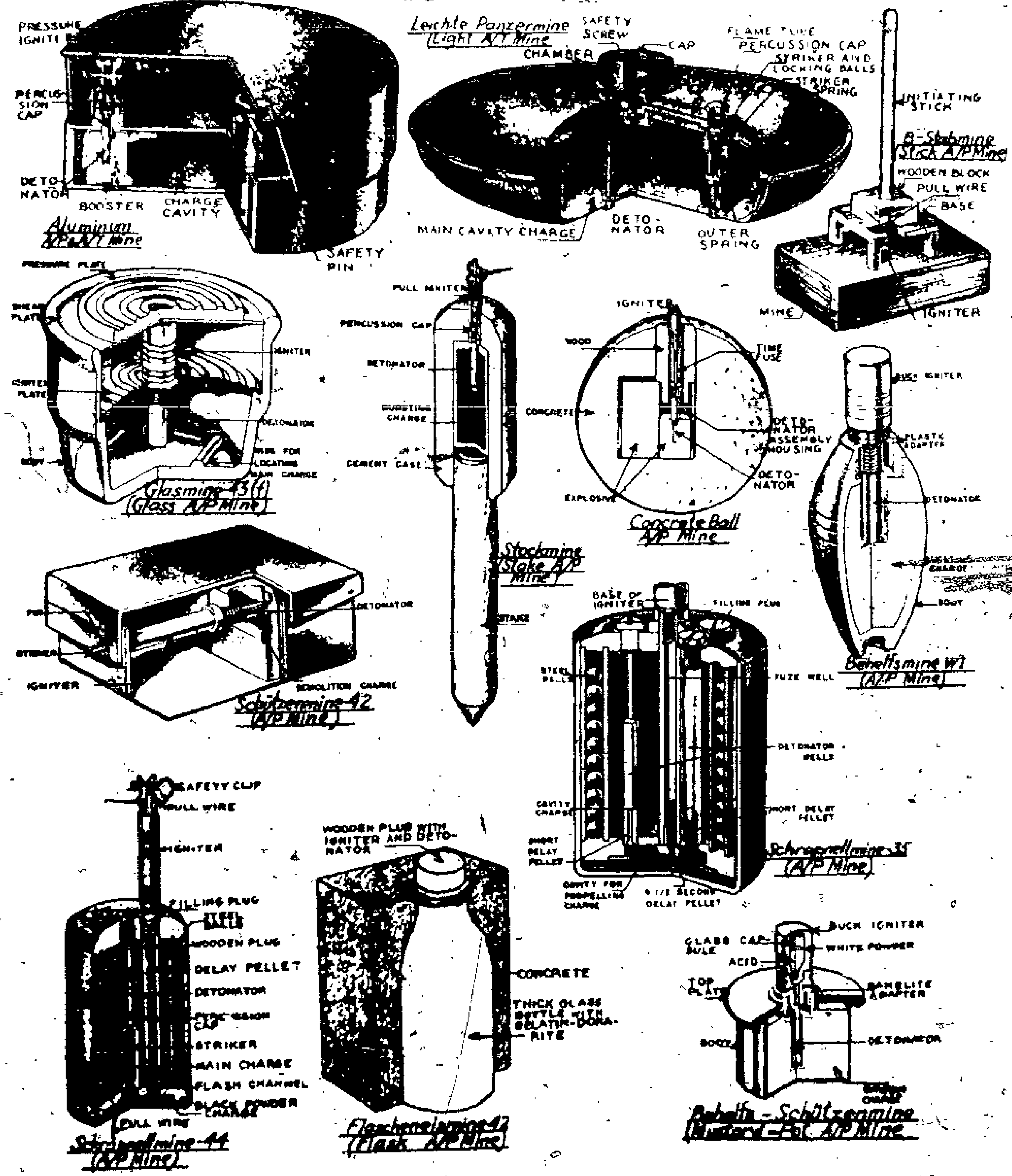
8) Pot-Shaped Antitank Mine (**Topfmine A**), also called Saucepan Mine, consisted of a plastic body filled with 12.5 lb of TNT or 50/50 Amatol. Total weight of the mine was 20 lb. Under a load of at least 150 kg (330 lb) the pressure plate sheared along its groove and thus came to rest on the head of the igniter. This in turn moved down and crushed two small glass capsules located inside the igniter body. The capsules contained chemicals* which on mixing produced a flash. This in turn set off the detonator and then the HE charge of the mine (Ref 4, p 81.08; 5, pp 26-9 and 6, pp 271-2)
9) **Clay Mines** were of two types: Antitank and Antipersonnel. The Antitank Mine consisted of a baked clay pot 8½" in diameter and 10" high with a wall ⅜" thick covered with a clay pressure lid about ⅝" thick. On opposite sides of the top of the pot were two round bulges which housed ZZ 42 igniters. Two hollow passages leading down inside each bulge carried the lengths of instantaneous fuse connecting ZZ 42 igniters with booster charges located at the bottom of the main charge, such as Picric Acid. Pressure on the lid pushed the pins out of the igniters, thus releasing the spring loaded strikers, etc. The Antipersonnel Clay Mine consisted of a round clay pot 8" in diameter and 3" high, with a wall ⅜" thick, provided with a cover. The charge of Picric Acid was detonated by means of the explosive train, consisting of four ZZ 42 igniters, a detonator and a booster, when a pressure equal to as little as a man's weight was applied to the lid (Ref 5, pp 38-41)
10) Antipersonnel or Antitank Aluminum Mine was filled with Cheddite (7 lb) and had a TNT booster. The body and the lid were of a flattened cylindrical shape. Three DZ 35 igniters together with No 8 detonators were inserted in boosters located 120° apart inside the main explosive charge. Pressure on the sides or in the center of lid set off one or more of the three igniters and the mine went off. Total weight of mine was 20 lb (Ref 6, pp 273-4)
11) Light Antitank Mine, **lPzMi** (Leichte Panzermine), which could be converted to antipersonnel use, consisted of two saucer-shaped, sheet metal covers forming an O-shaped container for 5 lb of TNT and an outer cover which served as a pressure plate. Five igniters were built into the mine and spaced radially around it. Pressure crushed the mine cover and forced one or more igniter housings downward over their plungers. This action compressed the outer spring, allowing the steel locking balls to be forced outward into upper recesses, releasing the striker, etc. For converting the mine to antipersonnel use the bottom igniter nuts were

*Note. According to Dr Hans Walther, one capsule contained liquid K-Na alloy and the other ethyl nitrate or nitric acid.

LAND MINES



LAND MINES



removed and the mine, resting on threaded ends of plungers was placed on a hard flat surface. Light pressure on the mine cover depressed the entire mine and forced the plungers upward into the igniter housings. The mine weighed 9 lb (Ref 4, p 81.05 and 6, pp 274-5)

12) Antipersonnel Mine, Glasmine 43(f), was made of glass and contained 7 oz of HE such as TNT or Picric Acid. The lid was a thin glass plate and served as a shear plate. When sufficient pressure was applied, the lid was broken and this action crushed the top of the Buck igniter or tripped the actuating lever of the Schuko igniter (Hebelzünder), depending on which device was used. The mine was made waterproof by applying a cement putty around the lid (Ref 4, p 82.06; 5, p 30 and 6, pp 275-6)

13) Concealed Antipersonnel Stickmine, called B-Stabmine, was made of wood, as a box 3½ x 6 x 10 inches. It contained a HE which was not specified. On top of the box was mounted a wooden support to hold a wooden block with an initiating stick. In the base of the block was a metal hook to which was attached a wire connected with the eye of the pull igniter ZZ 35, located in the cover of the box. Movement of the stick pulled the wire which set off the igniter (Ref 6, pp 276-7)

14) Antipersonnel Mine, called Stockmine, consisted of a concrete cylindrical body attached to a wooden stick, about 1.4" long, driven into the ground. The mine contained a standard borehole cartridge weighing 100 g and a pull igniter-detonator assembly. The concrete of the body held some pieces of shrapnel which were thrown in all directions when the mine exploded. A pull or pressure of 9 to 19 lb was sufficient to set off the mine (Ref 4, pp 82.02 and 6, pp 276-7)

15) Antipersonnel Concrete Ball Mine, which weighed about 2.2 lb, contained HE (about 1¼ lb) and an igniter-detonator assembly. Some shrapnel pieces were embedded in concrete. The mine could either be placed in the ground or rolled down a hill or cliff into enemy troops. In the last case the igniter was pulled by hand, prior to rolling the ball, thus igniting the time (safety) fuse connected to the primary charge of the detonator (Ref 4, p 82.05 and 6, pp 277-8).

Note: It seems that this mine was also called the **Rollbombe** (Rolling Bomb)

16) Antipersonnel Mine, called **Schützenmine 42**, abbreviated as **Schümine 42**, consisted of a wooden box containing a ½ lb demolition block together with a ZZ 42 igniter and a detonator. The box was covered with a hinged lid. Pressure on the lid pushed the pin out thus freeing the striker. Total weight was 1.1 lb. A modified version of Schumine used the ZZ 35 igniter (Ref 4, p 82.04 and 6, pp 278-9)

17) Antipersonnel Improvised Mine (**Behelfsmine W-1**) was made from captured French 50 mm mortar shell from which the nose fuze and tail fins had been removed. A Buck chemical igniter and a detonator were fitted inside the cavity in the HE charge, which was either Picric Acid or granulated TNT weighing 4 oz. A pull or pressure of not less than 35 lb was required to set off the mine (Ref 6, p 279)

18) Antipersonnel Mine, S-Mi 35, which might mean either **Schrapnellmine 35** or **Schützenmine 35**. The mine was also called **Bouncing Mine** because prior to the explosion the inner case of the mine was projected upward 3 to 5 feet. The British called this mine the "Fruit Tin" because it resembled a tin can in size and shape. The mine consisted of an outer steel case and an inner canister which held about 6½ oz of TNT or Amatol surrounded by about 350 shrapnel balls. A central steel tube running axially through the mine, contained in its upper part an igniter and in its lower part a 4½ second delay pellet. A black powder charge for ejecting the mine, was located beneath the inner canister. Three detonator tubes were spaced radially around the inner canister, 120° apart, and a short delay element was fitted into the bottom of each tube. The mine operated by pressure or by pull. In either case, when the igniter was fired its flame ignited the 4½ second delay element which in turn ignited the expelling charge. The resulting gas pressure forced the inner container upward into the air and at the same time ignited the short delay pellets in the three detonator tubes. The delay in these tubes was sufficient to permit the mine to rise in the air before the detonators in the tubes were set off. The detonators then exploded the main charge and the shrapnel balls were dispersed in all directions. The effective range was 200 yards. Various antilifting devices were employed with this mine (Ref 3; 4, p 82.01 and 6, pp 280-1)

19) **S-Mine 44** was similar in design to S-Mi 35, except that the S-Mi 44 used a push-pull type igniter (SMiZ 44) (which was not located in the center as in S-Mi35) and the mine detonated at a predetermined height of about 36" (Ref 6, pp 279-80).

Note: According to Ref 5, p 82.01-e there were other modifications of S-Mine and Ref 3 describes S-Mi 41.

20) **Eismine 42** (**Flascheneismine**) was an A/P Mine in the form of a wide-mouth bottle, intended for use under ice. The bottle contained 5 lb 10 oz of Gelatine-Donarit and was provided with a pull or pressure igniter. The mines were also used as antipersonnel land mines. For this they were encased in concrete containing shrapnel (Ref 6, pp 281-2)

21) **Behelfsschützenmine** was an improvised A/P mine in the form of a mustard pot and was loaded with powdered Picric Acid (4 oz). The mine was covered by a pressed steel lid with the Buck ignitor attached by means of an adapter. The detonator was inserted in the center of the HE charge. A moderate pressure on the top of the igniter was sufficient to set off the mine (Ref 6, pp 282-3).

Abbreviations: **A/P** Antipersonnel; **A/T** Antitank, **HE** High Explosive.

References:
1) A.B.Schilling, Pic Arsn Tech Rept 1246 (1943) (Tellermine)
2) A.B.Schilling, ibid 1377 (1944) (Tellermine Land Mine Type 4)
3) J.P.Wardlaw, ibid, 138[illegible] (1944) (Antipersonnel Mines S-35 and S-41)
4) Anon, Land Mines and Booby Traps, War Department Field Manual FM 5-31 (1943-1944), pp 81.01-82.06
5) Anon, Mines in the Spotlight, Intelligence Bulletin, March, 1945, pp 24-43
6) Anon, German Explosive Ordnance, Dept of the Army Technical Manual TM 9-1985-2 (1953), pp 261-83

Note: The following mines (which are not described in the above References) are listed in the "Enemy War Materials Inventory List", Supreme Headquarters, Allied Expeditionary Force (1945), pp 156-7: **Rampenmine** (Improvised Ramp Mine), **Landmine T-40(h)** and **No 2(h)** (Dutch Land Mines), **Panzerabwehrmine (b)** (Belgian A/T Mine), **Behelfsschützenminen S 150, A 200 & A 202** (Belgian Improvised Pot Mines), **Stangenladung** (A/P Mine, Pole Charges), **Behelfsmine E 5** (Improvised A/P Mine, consisting of 5 "egg" hand grenades), **Geschossmine 27 cm** (Improvised Mine, made from 270 mm shell), **Rollbombe** (Rolling Bomb), **Kugeltreibmine 41**, abbreviated as **KTrMi 41** (Spherical Drifting Mine, GL) and **Flusstreibmine 41**, abbreviated as **FlTrMi 41** (River Drifting Mine, GLP).

Lead Azide. See Bleiazid.

Lead Peroxide. See Bleiperoxyd.

Lead Picrate. See Bleipikrat.

Lead Styphnate (Bleitrinitroresorsinat). See Trizinat.

Leaflet Rocket. See Propaganda Rakete.

Leonit (Leonite). Permissible explosive consisting of K perchlorate 35, Am nitrate 10, Na nitrate 3, crude TNT 11, wood flour 7, NG 4 and alkali chloride 30%.

Reference: M.Giua et al., Dizionario di Chimica, UT-ET, Torino, (1951), p 166.

"Leopard". See Experimental Tanks under Panzer.

"Leopold" or "Annie Annie". A 280 mm Railroad Gun, Model 5 (28 cm K-5), designed during WW II by Gessner (See also Gessner Gun and under Weapons).

Leuchtbombe (Illuminating Bomb). See under Bombe and Flare.

Leuchtspursätze oder Lichtspursätze. See Tracer Compositions.

Lever Igniter (Hebelzünder). See Pressure Igniter, under Igniter

Lignofol. A highly compressed laminated wood used for the construction of the fins of some rockets; e g the Rheintochter [TM 9-1985-2 (1953), p 227].

Lignose Sprengstoffwerke G m b H, Berlin. See under Warplants and Arsenals.

Liquid Rocket Propellants. See Rocket Propellants, Liquid.

Littlejohn Gun or Squeeze-Bore Gun. See Note under Tapered Bore Gun.

LPZ Mine. A light antitank or antipersonnel land mine. It is briefly described in TM 9-1985-2 (1953), p 274.

LT (Low Tension) Electric Detonator. See Gasless Delay Detonator.

Luchs (Lynx). See under Panzer.

Lurgi Spaltanlage (Lurgi Cracking Plant) operated during WW II at the Schlebusch Fabrik, D A -G. It regenerated SO_2 (and later SO_3) from strong sulfuric acid contaminated with organic materials and suspended solids.

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The resulting SO_2 was used for the manufacture of oleum.

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Machine Gun (Maschinengewehr). See under Weapons.

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tubes was sufficient to permit the mine to rise in the air before the detonators in the tubes were set off. The detonators then exploded the main charge and the shrapnel balls were dispersed in all directions. The effective range was 200 yards. Various antilifting devices were employed with this mine (Ref 3; 4, p 82.01 and 6, pp 280-1)

19) S-Mine 44 was similar in design to S-Mi 35, except that the S-Mi 44 used a push-pull type igniter (SMiZ 44) (which was not located in the center as in S-Mi35) and the mine detonated at a predetermined height of about 36" (Ref 6, pp 279-80).

Note: According to Ref 5, p 82.01-e there were other modifications of S-Mine and Ref 3 describes S-Mi 41.

20) Eismine 42 (Flascheneismine) was an A/P Mine in the form of a wide-mouth bottle, intended for use under ice. The bottle contained 5 lb 10 oz of Gelatine-Donarit and was provided with a pull or pressure igniter. The mines were also used as antipersonnel land mines. For this they were encased in concrete containing shrapnel (Ref 6, pp 281-2)

21) Behelfsschützenmine was an improvised A/P mine in the form of a mustard pot and was loaded with powdered Picric Acid (4 oz). The mine was covered by a pressed steel lid with the Buck ignitor attached by means of an adapter. The detonator was inserted in the center of the HE charge. A moderate pressure on the top of the igniter was sufficient to set off the mine (Ref 6, pp 282-3).

Abbreviations: A/P Antipersonnel; A/T Antitank, HE High Explosive.

References:
1) A.B.Schilling, Pic Arsn Tech Rept 1246 (1943) (Tellermine)
2) A.B.Schilling, ibid 1377 (1944) (Tellermine Land Mine Type 4)
3) J.P.Wardlaw, ibid, 13[illegible] (1944) (Antipersonnel Mines S-35 and S-41)
4) Anon, Land Mines and Booby Traps, War Department Field Manual FM 5-31 (1943-1944), pp 81.01-82.06
5) Anon, Mines in the Spotlight, Intelligence Bulletin, March, 1945, pp 24-43
6) Anon, German Explosive Ordnance, Dept of the Army Technical Manual TM 9-1985-2 (1953), pp 261-83

Note: The following mines (which are not described in the above References) are listed in the "Enemy War Materials Inventory List", Supreme Headquarters, Allied Expeditionary Force (1945), pp 156-7: Rampenmine (Improvised Ramp Mine), Landmine T-40(h) and No 2(h) (Dutch Land Mines), Panzerabwehrmine (b) (Belgian A/T Mine), Behelfsschützenminen S 150, A 200 & A 202 (Belgian Improvised Pot Mines), Stangenladung (A/P Mine, Pole Charges), Behelfsmine E 5 (Improvised A/P Mine, consisting of 5 "egg" hand grenades), Geschossmine 27 cm (Improvised Mine, made from 270 mm shell), Rollbombe (Rolling Bomb), Kugeltreibmine 41, abbreviated as KTrMi 41 (Spherical Drifting Mine, GL) and Flusstreibmine 41, abbreviated as FlTrMi 41 (River Drifting Mine, GLP).

Lead Azide. See Bleiazid.

Lead Peroxide. See Bleiperoxyd.

Lead Picrate. See Bleipikrat.

Lead Styphnate (Bleitrinitroresorcinat). See Trizinat.

Leaflet Rocket. See Propaganda Rakete.

Leonit (Leonite). Permissible explosive consisting of K perchlorate 35, Am nitrate 10, Na nitrate 3, crude TNT 11, wood flour 7, NG 4 and alkali chloride 30%.

Reference: M.Giua et al, Dizionario di Chimica, UT-ET, Torino, (1951), p 166.

"Leopard". See Experimental Tanks under Panzer.

"Leopold" or "Anzio Annie". A 280 mm Railroad Gun, Model 5 (28 cm K-5), designed during WW II by Gessner (See also Gessner Gun and under Weapons).

Leuchtbombe (Illuminating Bomb). See under Bombe and Flare.

Leuchtspursätze oder Lichtspursätze. See Tracer Compositions.

Lever Igniter (Hebelzünder). See Pressure Igniter, under Igniter

Lignofol. A highly compressed laminated wood used for the construction of the fins of some rockets; e g the Rheintochter [TM 9-1985-2 (1953), p 227].

Lignose Sprengstoffwerke G m b H, Berlin. See under Warplants and Arsenals.

Liquid Rocket Propellants. See Rocket Propellants, Liquid.

Littlejohn Gun or Squeeze-Bore Gun. See Note under Tapered Bore Gun.

LPZ Mine. A light antitank or antipersonnel land mine. It is briefly described in TM 9-1985-2 (1953), p 274.

LT (Low Tension) Electric Detonator. See Gasless Delay Detonator.

Luchs (Lynx). See under Panzer.

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Machine Gun, MG 42 (Maschinengewehr 42) is a 7.92 mm weapon developed in 1942 and which served during WW II as the basic weapon of the infantry squad. All its parts were manufactured by stamping. It could fire up to 1,200 rounds per minute. For a more detailed description see: M.M.Johnson, Jr, Army Ordnance 30, 352-58 (1946) and G.M.Chinn, The Machine Gun, U S Navy, Bureau of Ordnance, Washington, D C, v 1 (1951), p 484.

Made-up-Charge. According to the description given in PB Rept 925 (1945), p 18, the Germans designed the following system of propellent loading intended to replace the bag loading in large caliber guns:

A large cylindrical casing, 18" diameter and 6 ft long, made of sheet smokeless propellant 3/16" thick, was closed at each end with a disc of the same material. Each disc had a hole, 3" diameter, through which was inserted a long pipe which was made of smokeless propellant, and perforated with numerous holes ½" diameter. The space between this inner tube and the walls of the cylinder was filled with grains of a propellant of desired shape, size and calorific value. The inner perforated tube served to convey the flash from the igniter charge to the propellent charge.

It was claimed that the propellent charge of the so-called "Sevastopol Gun" was made on the above principle.

"Madrid" Infrared Homing Device. See under Guidance Systems for Missiles.

Magnesium Oxide (MgO), described in the general section, was included as a component of many German solventless extruded propellants. It was claimed that MgO greatly facilitated the extrusion process. The composition of some propellants contg 0.05 to 0.25% Mg is given in PB Rept 925 (1945), p 85-91. (See also under Propellants).

Magnetic-Ballistic Guidance System for Missiles. See under Guidance Systems for Missiles.

Magnuskraft (Magnus Effect). See general section and also books on Ballistics.

Mannol. Trade name for Ethylacetanilide described in the general section. Its 20% alcoholic soln is a good gelatinizer at 55° or higher temperatures for collodion cotton.

Reference: Kast-Metz, Chemische Untersuchung (1944), p 160.

Manöverpulver (Maneuver or Blank Fire Propellant). The following compositions are given in Brunswig, Das rauchlose Pulver, (1926), p 136: a) guncotton 97, diphenylamine 1.0, moisture 1.0 and gelatinizer [illegible]% b) guncotton 67, NG 32, moisture 0.5 and gelatinizer 0.5%.

MAN-Salz (Man-Salt). Described as Methylamine Nitrate in the general section. The German technical salt had a m p ca 103°, while the purified material was 109-110°.

One of the German methods for preparation of MAN-Salz was as follows:

Methylamine (97-98.5% purity) and weak technical nitric acid (45 to 66%) were mixed continuously at the rates of 1240 and [illegible] parts by weight per hour respectively. The [illegible]

about 70° so that the heat of neutralization could be utilized at the same time for the vacuum concentration of the salt in order to avoid using too much steam. The resulting solution of methylamine nitrate in acidic water was concentrated at about 50° to about 85% strength. The concentrated aqueous liquor, which had a pH of 6.5 to 7 was cooled to 20° with water while being stirred, and the first crop of crystals collected (about 40% of the total salt). Then the solution was cooled to -10° to recover another 40% of the product. A centrifuge was used to remove the crystals. The mother liquor (about an 87% solution of MAN-Salz) was used to wash both batches of crystals in the centrifuge; a total of about 10% by weight of the centrifuge charge was used for a washing. Three washings were made. About 2/3 of the final mother liquor was returned to the evaporation cycle, the other 1/3 to the salt regeneration and purification. Final drying was done in stoves or by blowing hot gas through the molten salt; pH control was necessary for economical recovery (Ref 1, p 22).

According to German sources, the heat of explosion of MAN-Salz is 1200 kcal/kg vs 1000 for TNT, the volume of gases produced at NTP (0° and 760 mm Hg) 834 l/kg vs 780 for TNT and the velocity of detonation 6600 m/sec vs 6200 for TNT, at a density not indicated. The salt is practically insensitive to shock and stable even when held at temperatures ranging up to 150°. In order to insure the maximum detonation rate of MAN-Salz, it is advisable to mix it with a small amount (as low as 5%) of RDX (or PETN). MAN-Salz is hygroscopic, but the hygroscopicity is reduced on the addition of Na nitrate or other substances. A mixture of MAN-Salz with Am nitrate and 15% RDX has a heat of explosion of 1120-1260 kcal/kg, volume of gases 740 l/kg and velocity of detonation 6700 m/sec. It is insensitive to shock and can be cast-loaded (Ref 3).

Uses: Due to the high m p of MAN-Salz, it was considered unsafe to cast-load it into shells or bombs. This difficulty was overcome by incorporating some Am nitrate, as for instance: MAN-Salz 25 to 30, Tri-Salz 1 to 3 and Am nitrate 67 to 74%. This mixture called *Formit* softened and exuded at 60-70° and was considered not very suitable for use in shells. However, suitable m ps were obtained when ammonium nitrate was replaced by Na nitrate, as in the following mixture: MAN-Salz 58 parts, Na nitrate 42 and RDX 15. (Ref 3). This explosive composition was practically oxygen balanced and proved to be suitable for use in shells and bombs. It proved also safe against shock or bullet impact, but it detonated when hit by a bomb or shell. A similar mixture was known as C6 (see Ref 2).

In order to eliminate the danger of detonation of projectiles (filled with MAN-Salz) in the course of shipping them to the front, it was proposed to incorporate 10-15% of water in the MAN-Salz. This amount of water was sufficient to render the MAN-Salz insensitive to shock or to sympathetic detonation. In order to make these mixtures sensitive to initiation, it was only necessary to add to the contents of projectiles (before use) some highly concentrated nitric acid and about 15% of a highly dispersed inorganic agent, such as silica or alumina. In order to prevent corrosion from the nitric acid the inside of the projectile was coated with acid-proof paint, such as a hydrocarbon-type high polymer.

MAN-Salz was also used in mining explosives, where it was usually mixed with Na nitrate (the eutectic melts below 50°) and a small amount of hydrated starch or other gel (to render the mixture plastic). Small quantities of RDX or PETN could be incorporated when it was desired to increase the velocity of detonation of the explosive.

References:

1) O.Stickland et al, General Summary of Explosive Plants, PB Rept 925 (1945), p 22
2) G.Römer, Report on Explosives, PBL Rept 85,160 (1946), p 25
3) H.Walter et al, German Development in High Explosives, PB Rept 78,271 (1947), pp 4-7.

MAN-Salz Perchlorat (Man-Salt Perchlorate, Methylammonium Perchlorate) was prepd by Walter et al by neutralizing monomethylamine with perchloric acid. As this explosive had a high m p and was highly sensitive to shock, it was necessary to use it in mixtures with substances which would lower its sensitivity as well as its m p. The low m p was desirable in order to be able to cast-load the explosive. Such mixtures could be obtained by boiling under reflux, a solution of Am perchlorate in commercial aqueous formaldehyde. After distilling off the water and other volatiles, a solid explosive, m p 90-100°, was obtained. It was compatible with RDX. As it was inferior to MAN-Salz, no further investigation was made [Walter, PB Rept 78, 271 (1947), p 7].

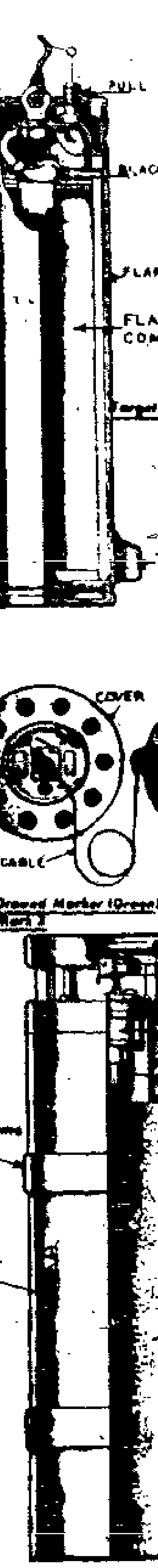
Mantelpatrone (Sheathed Cartridge). A short description of sheathed explosives is given in the general section. During WW II, the Germans used "active sheaths" (q v) for housing explosives such as Wetter-Wasagit A.
(See also References under Active Sheath).

Marabu. One of the proximity fuzes developed during WW II in Germany. The device is mentioned on p 229 of TM 9-1985-2 (1953).

Marder (Marten) (Called by the French "torpille humaine") A device developed in 1944 consisting of a torpedo with a warhead and another on top of it containing no explosive, but a small cabin to house one man. The two torpedos were attached to each other in such a manner that it was easy to disconnect them when necessary. The ensemble was launched from a ship or shore against a target and when it approached to within 100 or 200 m the operator took good aim and detached the lower torpedo contg the warhead. This left the upper torpedo (contg the cabin) afloat by itself. After this, the operator had to swim towards his ship or shore on the upper torpedo.
[A.Ducrocq, Les Armes Secrètes Allemandes, Berger-Levrault, Paris (1947), pp 33-34].

Marder II. A self-propelled mount (also called tank destroyer) consisting of the 75 mm A/T Gun or of the 150 mm Heavy Infantry Gun on PzKpfw II tank (See also under Panzer).

Marder 38. A self-propelled gun mount utilizing one of the varieties of Czech tank T-38 (See under Panzer).



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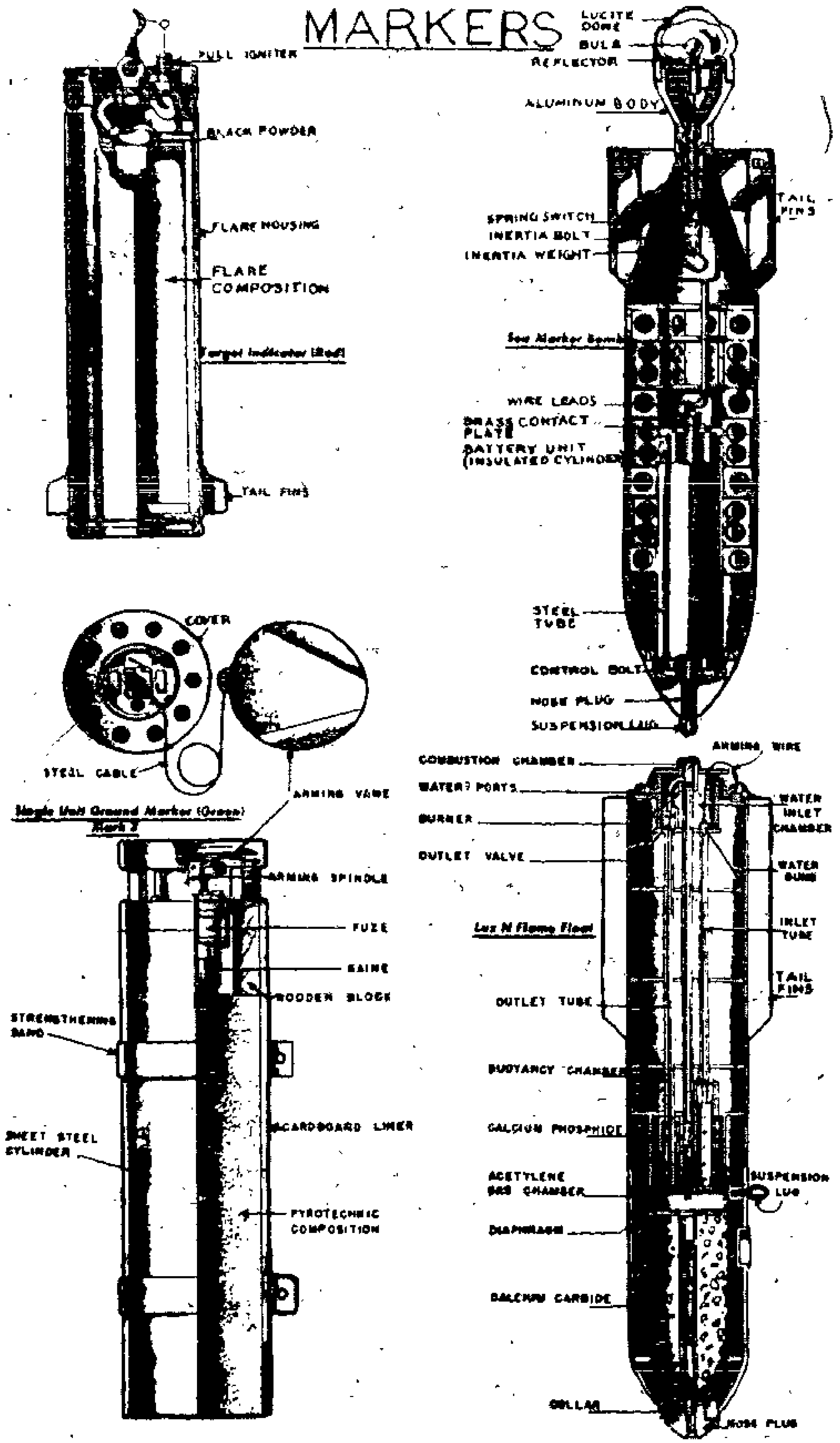
MARKERS



Marine Explosives of WW I and WW II. Under this title, A.Stettbacher, in Protar (Switzerland) 9, 33-45 (1943), describes the explosives used by the Germans for filling torpedoes, sea mines, depth charges etc:

a) Explosive of WW I: TNT 60, HNDPhA (hexanitrodiphenylamine) 40%

b) Explosive of WW II: TNT 61.8, HNDPhA 23 and Al powder 15.2%

The second mixture was much more effective than the first one.

Marine-Geschütz Pulver. Black powder used as a burster in photoflash bombs, such as BLC 50/A bomb. The composition of the powder was: K nitrate 75, sulfur 9 and beech charcoal 16%. The granulation was 0.68 to 1.3 mm and the moisture content 1.3%.
Reference: TM 9-1985-2 (1953), p 82.

Mark 50 Kaskade (Cascade Flare Bomb). See under Pyrotechnic Anti-Pathfinder Devices.

Marker (Anzeiger). A pyrotechnic device used to mark a position. Most of the German markers consisted of cylindrical cardboard containers filled with a colored flare composition which was ignited by an impact type fuze. Some markers merely contained a brightly colored powder, which was dropped into the sea from low altitudes to mark positions. Others were modified parachute flares of various colors. The following devices, described in TM 9-1985-2 (1953), could be classified as markers:

1) NC 50 WC NC D/SEE, Smoke Marker Bomb resembled an ordinary HE bomb. It consisted of an aluminum outer casing (empty except for metal ribs and braces), tail cone, nose and central cylinder which protruded from the nose and extended aft to the forward part of the tail where it was terminated by a fuze housing crimped to it. Waterproofing at the tail was provided by a rubber seal. The central cylinder contained the smoke producing agent. Four fins and a plate (called drogue) were attached to the tail end. Impact of the bomb on water caused the drogue, together with the fuze release rod, to be wrenched off. This action fired the fuze and ignited the smoke mixture. At this time the bomb would be floating on the surface. Eventually the heat from the burning smoke composition destroyed the rubber seal and the smoke was vented to the outside, thus indicating the position of the marker (pp 58-9)

2) Mark S Flare, Types 1 and 2. Floating devices which could serve as markers or for signalling purposes (See under Flare and in TM 9-1985-2, pp 77-8)

3) Target Indicator (Red) consisted of an aluminum cylindrical casing housing a flare composition enclosed in a cardboard cylinder. The suspension plate at the tail held an eye to take the parachute shackle, and a pull igniter which was connected by a 4¾ inch length of safety fuse to a small bag contg black powder. This served both to set off the igniter pellet in the top of the candle and to eject the latter from the casing when it fell freely to earth and acted as a ground marker. The pull igniter was attached to the loop of the shroud lines by a cord and the opening of the parachute gave the necessary pull for operating the igniter. There were (for some unknown purpose) two small fins at the nose end of the container (pp 84-5)

4) Sea Marker Bomb consisted of sheet steel, bomb-shaped container, supported internally by a series of annular strengthening bulkheads. The tail end of the bomb was provided with four stabilizing fins and an extension housing a lamp unit covered with a lucite dome. A battery of six dry cells was housed in the center of the bomb. At the moment of the release of the bomb from the aircraft, the inertia bolt was positioned between the plates of the spring switch in such a manner that one side of the circuit between the lamp and the batteries was broken. On impact of the bomb, the inertia bolt was forced out of position and the circuit between the lamp and battery was completed. As the batteries filled only a portion of the bomb body and as all joints were made tight by rubber washers, the marker floated on the surface of water. It is assumed that the marker provided a recognition or bearing point for aircraft (pp 85-6)

5) Sea Marker LUX EZ 50 SC was constructed of sheet steel in two parts (nose and tail) loosely joined together about 1/3 the distance from the nose. Its external view and a brief description are given on p 87 of TM 9-1985-2 (1953)

6) Mark 3 Grün (Single Unit Ground Marker, Green) consisted of a sheet steel cylinder enclosing a cardboard container with the pyrotechnic composition, a fuze with spine (filled with black powder), an arming spindle and an arming vane, which was loosely fitted within the housing. On release of the marker from the aircraft, the current of air rushed through the vent holes in the arming vane, thus ejecting it from the housing. By reason of its shape, the arming vane rotated as the missile was falling. This rotation unscrewed the arming spindle of the fuze thus permitting its clockwork mechanism to function. At the expiration of predetermined delay, the black powder in the same became ignited. The resulting flash ignited the pyrotechnic composition and at the same time a slight explosion took place which ejected the cover cap, fuze and arming vane housing. The pyrotechnic filling burned for about 3½ minutes.

7) Lux N Flame Float. A bomb-like device constructed of sheet steel and provided with four fins. When released over water the device went under the surface thus allowing the water to enter the ports and to pass down the inlet tube into the calcium phosphide chamber. The resulting reaction produced phosphine gas which passed up the outlet tube through the nonreturn valve to the burner where it ignited spontaneously to form a pilot jet. At the same time, water entered through the channels in the nose and passed through a perforated tube into the calcium carbide compartment. The acetylene evolved passed through the perforated diaphragm into one compression chamber and thence to the burner where it was ignited by the pilot jet (pp 91-2)

8) Lux S Flame Float (Types 1, 2 and 3) was cylindrical in shape and contained, as in the previous device, Ca phosphide and Ca carbide (pp 92-3).

Marspille or Mars Priming Drops. Low tension fuseheads intended for ordinary instantaneous detonators. They were manufactured by dipping the tip of the electric bridge wire into the following liquids:

a) 1st dip composition consisted of 100 g of dry Pb picrate suspended in 50 ml of a 2% solution of NC in amyl or butyl acetate. After the drop on the tip became dry it was dipped into

b) 2nd dip composition consisting of Pb picrate 40 g, K perchlorate 35 g and alderwood charcoal 25 g, suspended in 50 ml of a 2% solution of NC in amyl or butyl acetate

c) 3rd dip composition contained K perchlorate 85.7 and alderwood charcoal 14.3 g, suspended in about 50 ml of a 3% solution of NC in amyl or butyl acetate

d) 4th dip composition was a lacquer consisting of a 15% solution of NC in 75/25 butyl acetate ethanol to which was added (20% of the dry weight of NC) Sipolin AOM (which is the methylcyclohexyl ester of adipic acid), and 17 g of Sudan Brown for each 10 l of liquid.

Notes: A) For material to be used in tropical countries, the 4th dip contained Al powder (200 g per liter of lacquer), which was supposed to protect the fusehead against static electricity

B) Marspille possessed the property of not igniting firedamp, which was a great advantage

C) The soldering of the bridge wire to lead-in wires, the preparation of dry ingredients for fusehead dips, the preparation of NC varnishes and the process of dipping the fuseheads are described under Fusehead Manufacture.

References:
1) B I O S Final Rept No 833, Item 2(1946), p A3/36
2) PB Rept No 95,613 (1947), Section D.

Maschinengewehr (Machine Gun). See under Weapons.

"Maus" (Mouse). A heavy tank designed by Porsche (See Experimental Tanks, under Panzer).

Meganit (Meganite). One of the WW I straight dynamites: NG 60.0, nitrated wood pulp 10.0, nitrated ivory nut meal (corozo) 10.0 and Na nitrate 20.0% [P.Naoum, Nitroglycerin, Baltimore (1928), p 284].

Mehlpulver (Meal Powder). A finely pulverized black powder used in pyrotechnic compositions. Its preparation is decribed by A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 103 (See also Meal Powder in the general section).

Melan. A jelly originally prepared by Sprengstoffe A-G Carbonit, Schlebusch, by boiling glycerin with an aqueous solution of glue. It was incorporated in some dynamites in order to increase their plasticity. Some glycerin-glue mixtures contained dextrin (See also Gelatine-Carbonit and Safety Jelly Dynamite).
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Meldebüchse (Message Container or Message Tube). A device for dropping messages. Two types of containers used for this purpose are described in TM 9-1985-2 (1953), pp 120-1:

a) Sea Message Tube consisted of an aluminum cylinder in which the upper compartment contained a smoke composition, whereas the lower (airtight) compartment carried a message. On dropping the missile from a plane, the friction igniter was pulled and the resulting flash ignited the delay fuse, which in turn ignited the bottom part of the smoke composition. When persons for whom the message was intended, saw the smoke, they approached the missile and removed the message container by opening the cap (at the rear of the tube) and pulling the chain (p 120)

b) Land Message Tube was also cylindrical in shape and consisted of two compartments. The smoke composition in the upper compartment was ignited by means of four strands of quickmatch which extended down the side of the smoke container and met several pieces of quickmatch below the smoke container. The strands were ignited when the friction igniter was pulled on dropping the missile from a plane. The message was withdrawn by unlocking the nut and removing the cover. (p 121).

Mercuric Fulminate. See Knallquecksilber.

Message Pistol Grenade (Nachrichten Pistolengranate). See under Pistol Grenades.

Message Tube. See Meldebüchse.

Messei (Measuring Egg). A device designed at the Krupp plant for measuring the pressure developed in guns. The extent to which a copper cylinder was compressed by the gases of combustion of a propellant served as a measure of the maximum pressure developed in chamber. For more information on this subject, see H.Brunswig, Das rauchlose Pulver, Berlin (1926), p 412.

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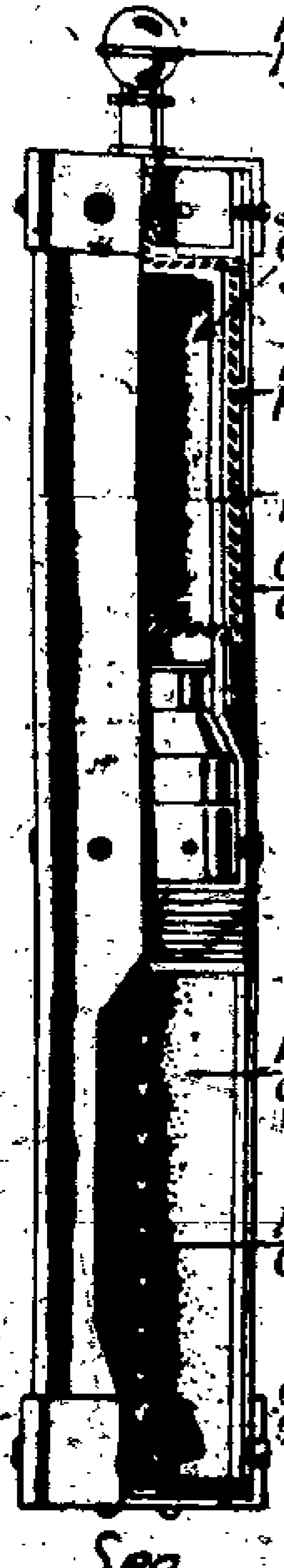

Sea Mess...

Methylamine. Its pr... the general section. ... amine was never us... of its nitrate, calle...

Methylamine Nitrate ...

Methylnitropropaned...

... described in the ge... during WW II as a ... It was found to be ... sizer for NC.
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aircraft.(pp 85-6)

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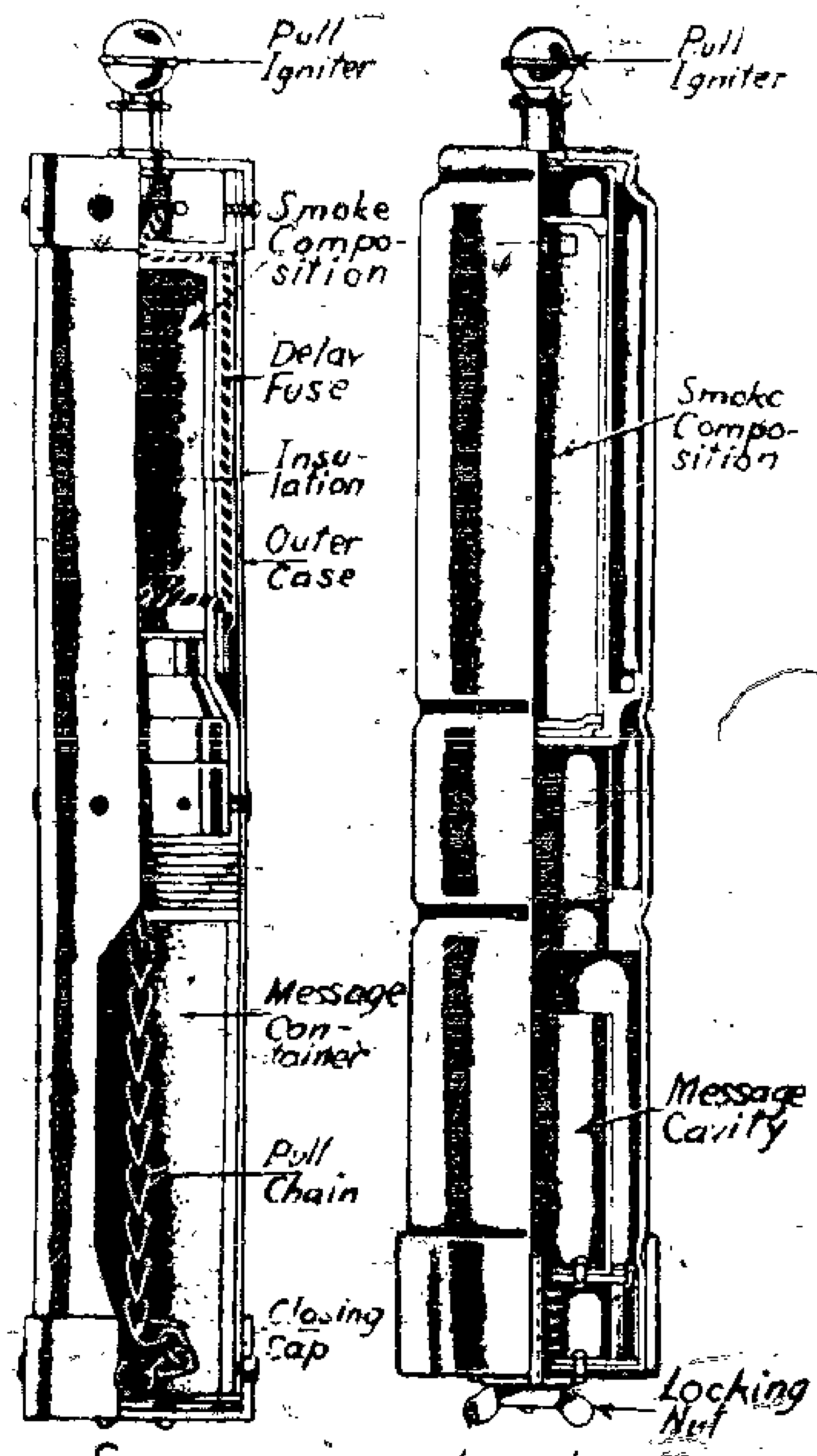

Sea Land
Message Tubes

Methylamine. Its preparation and properties are given in the general section. According to Dr H. Walter, methylamine was never used in Germany per se but in the form of its nitrate, called Man-salz (qv).

Methylamine Nitrate See Man-Salz.

Methylnitropropanediol Dinitrate, $(O_2N)(H_3C)C(CH_2ONO_2)_2$

described in the general section, was examined in Germany during WW II as a possible substitute for NG in propellants. It was found to be fairly stable but not a very good gelatinizer for NC.
Reference: PB Rept 925 (1945), p 15.

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PICATINNY ARSENAL
TECHNICAL REPORT NO. 2510

DICTIONARY OF EXPLOSIVES, AMMUNITION AND WEAPONS

(GERMAN SECTION)

BASIL T. FEDOROFF

HENRY A. AARONSON GEORGE D. CLIFT EARL F. REESE

DOVER, NEW JERSEY

1958

Methylstoff. A mixture of aluminum dichloromethyl, $AlCl_2\text{-}CH_3$, and aluminum chlorodimethyl, $AlCl(CH_3)_2$, proposed as a substitute for phosphorus in incendiary compositions. The mixture was prepared by passing methyl chloride vapor through copper-free aluminum turnings.
Reference: R.E.Richardson et al, CIOS 25-18 (1945), pp 4-5.

Metrioltrinitrat (Metriol Trinitrate), (Methyltrimethylol-methane Trinitrate or Pentaglycerin Trinitrate), $H_3C.C(CH_2ONO_2)_3$, described in the general section, was developed in Italy before WW II by Bombrini Parodi-Delfino and adopted later by the Germans.

The following method of preparation was used at the Krümmel Fabrik of D A -G :

a) 50 kg of finely pulverized and sieved Metriol was slowly fed with stirring by means of a worm screw, into a stainless steel nitrator containing 175 kg of mixed acid, (65% HNO_3 and 35% H_2SO_4) maintained at 20°. Formation of lumps had to be avoided because this could lead to overheating and decomposition of metriol and acid

b) After 20 minutes of nitration, 15 minutes were allowed for separation of the oil from the acid

c) The separated oil was washed, first with water, then with soda ash soln and finally with water. The temperature during all the washings was maintained at 40° because at a low temp the mixture was too viscous. The soda ash wash lasted for 20 minutes. The yield was 200 parts MtrT per 100 p of Mtr

d) The washed oil was taken to a storage tank from which it was withdrawn when needed for the preparation of "Rohpulvermasse" (Rawpaste) (q v).

German technical MtrT was a heavy oil, practically insol in water, with the following properties: N=16.00% to 16.32%, d 1.460 at 20°, stability by Abel test at 82° 20 mins, decomposition temperature ca 182°, impact sensitivity with a 2 kg hammer 4 cm, calorific value 1270 kcal/kg (water in liquid phase), volatility less than NG.

It was used in some smokeless propellants as an explosive plasticizer for NC in lieu of NG.
Reference: PB Rept 925 (1945), pp 15 & 61.

Miedziankit (Miedziankite). A type of chlorate explosives manufactured in Germany and Poland before WW II: a) K or Na chlorate 88-91 and liquid, hydrocarbons (with flash point not below 30°C) 12-9% (Ref 1); b) K chlorate 90 and petroleum 10%. The first mixture belonged to the group of Chloratites 3.
References:
1) P.Naoúm, Shiess- und Sprengstoffe (1927), p 131
2) A.Stettbacher, Spreng- und Schiesstoffe (1948), p 91.

Mikroverzögerung beim Sprengen (Microdelay in Blasting) is described by Z.Peithner, Explosivstoffe 1954, Heft 5/6, pp 68-70.

Mine, Land. See Landminen.

Minenhund (Mine Dog), called by the Allies "Doodlebug" or "Goliath", was a miniature two-track tank operated by remote control through a 590 yd 3 strand cable which unwound from a drum on the tankette. Separate electric motors, each powered by its own storage battery, drove the two tracks of the tank at a speed up to 4 mph. Steering was done by braking the tracks. The tank contained about 250 kg HE demolition charge which the remote-control operator was supposed to touch off after stopping the vehicle at its target.

These mobile mines were not very effective because they could not move in reverse. On account of their low speed and thin armor, they were easily destroyed by the Allies' artillery.
Reference: Anon, Field Artillery Journal 34, 505 (1944).

Miniature Tornadoes. See Explosive Powered Vortices.

Mining Effect. See Earth-Displacement Test.

Mining Explosives. See Commercial Explosives.

Mipolam and Mipolam Sealing Plugs. Mipolams are plastic compositions developed in Germany during WW II and used in the prepn of seals for some delay detonators. Previous to WW II lead seals were used. The Mipolam sealing plugs were made in three types:

a) Long greyish-green plug with a single hole

b) Short greyish-green plug with two holes. The Mipolam was composed of polyvinyl chloride 50, tricresyl phosphate 30 and talcum 20%

c) Short reddish plug with two holes. The Mipolam was composed of polyvinyl chloride 51, Special Mixture 31, and talcum 18%.

Note: The Special Mixture consisted of 2 parts tricresyl phosphate 2 pts Palatinol HC and 2 pts Palatinol K. The composition of Palatinol HC was not given, and the Palatinol K was butyleneglycolphthalate.

Mipolam was also used for covering the lead-in wires of electric detonators. The thickness of coating for 60 mm wires was only 0,25 mm on detonators not intended for underwater operations and 0.35 mm on those intended for such operations.
References:
1) W.Krannich, Kunststoffe im technischen Korrosionsschutz, Lehmann, Berlin (1943), p 25
2) B I O S Rept (Final), No 833, Item No 2, London (1946) or PB Rept No 63,877 (1946)
3) PB Rept No 95,613 (1947), Sections H, I and J.

Note: According to M.F.Fogler et al, CIOS Rept 21-3 (1945), p 5 there were three types of Mipolam: a) Plasticized polyvinyl chloride b) Copolymers of polyvinyl chloride and acrylic esters and c) Polyvinyl chloride and maleic esters.

Mischmetall (Mixed Metal) was an alloy of rare earths of the following approx compn: Ce 49.0, La 25.6, Nd 16.0, Pr 4.6, Sm 2.0, Tb 1.0, Y 1.0, and Fe 0.8%. It was used as a component of delay elements for electric blasting caps. Other ingredients of delay elements included: Mg, Al, Ni and Zn homogeneously mixed with a fuel such as Si and an oxidizing agent such as Pb_3O_4.
Reference:
H.M.Kerr, C.R.Hall, U S P 2,560,452 (1951); C A 44, 1259 (1952).

Mischsatz (Mixed Charge). Designation for a mixture of lead azide and lead styphnate for use in detonators. (See also Sprengkapsel A und Sprengkapsel B).
Reference:
W.Schneider, Sprengtechnik, 1952, No 10/11, p 186.

Mittel AEP (Agent AEP). Trade name for Ethyl Ester of p-Toluenesulfonic Acid, $H_3C.C_6H_4.SO_2OC_2H_5$; white crystals m p 31-32°. Its solution in organic media was claimed to be a good gelatinizer for NC.
Reference:
Kast-Metz, Chemische Untersuchung, Braunschweig (1944), p 161.

Mittel KP (Agent KP). Trade name for Cresyl Ester of p-Toluenesulfonic Acid, $H_3C.C_6H_4.SO_2OC_6H_4CH_3$; brown oil d 1.207 at 15°. Its soln in organic media was claimed to be a good gelatinizer for NC.
Reference: Kast-Metz, Chemische Untersuchung, (1944) p 161.

Mollit I. German trade name for Centralit I.

Mollit II. German trade name for Centralit II.

Monachit (Monachite). According to Marshall (Ref 1) monachites were Favier type explosives. According to Colver (Ref 2) these explosives were invented by Kast in Germany. Table 26 gives the composition of some monachites.

Table 26

Designation	Am nitrate	K and/or Na nitrate	TNX	Collod cotton	Flour	Char-coal	Alkali chloride
Monachit I	81	5	13	-	1	-	-
Monachit II b	64	3	14	1	-	1	17
Monachit II d	64	3	12	1	-	1	19

Abbreviation: TNX Trinitroxylene

According to Stettbacher (Ref. 3), Monachit was an explosive suitable for loading projectiles and it was prepared by mixing ammonium nitrate with the solid and liquid products of nitration of solvent naptha.
(See also Filler No 57, under Fillers).
References:
1) Marshall v 1 (1917), p 392
2) Colver (1918), pp 258 & 634
3) Stettbacher, Schiess- und Sprengstoffe (1933), p 278.

Monobel, See general section.

Morter (Mörser). See under Weapons.

Morter Bomb. See under Bombe.

Morter Shell. See under Granate and under Spigot Mortar Projectile.

MP-14 (Solid Catalyst) used for decomposing the T-Stoff (hydrogen peroxide) of liquid rocket propellants.

Broken porcelain pieces, previously soaked in a 50% soln of Z-Stoff (q v) and dried at 110° for 24 hours, were cooked for 10 minutes in a 50% soln of 2 parts Ca permanganate and 1 part K chromate and then redried at 110° for 24 hours.

When generating steam from T-Stoff, copper coils were mixed with MP-14 in order to accelerate initial decomposition. The ratio of catalyst to copper was about 2 to 1.
Reference: CIOS Rept 30-115 (1945), p 11.

M-Stoff Commercial methyl alcohol, sp gr 0.796, used as a component of some liquid rocket fuels, such as C-Stoff (CIOS 30-115, p 10).

"Multipede". Same as Hochdruck Pumpe (High-Pressure Pump).

Munition. See Ammunition.

Mustard Pot Mine. See under Landminen.

Muzzle Charging Device, used for finer adjustment of the range of some electrical time fuzes, consisted of a cylinder which fitted around the barrel of a gun just behind the muzzle and was connected by means of an electrical cable to a battery and a voltage-control mechanism located at the breech end of the gun. A charging ring, located in front of the muzzle, was held by means of three arms placed 120° apart. These arms also served for conducting the electric current from the cylinder to the ring. When a projectile equipped with an electrical time fuze, such as the Type S/30 (ElZtZ 5/30), reached the muzzle, the "feeler wire" (located on the outside of the fuze and connected to

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2) Colver (1918), pp 258 & 634
3) Stettbacher, Schiess- und Sprengstoffe (1933), p 278.

Monobel. See general section.

Mortar (Mörser). See under Weapons.

Mortar Bomb. See under Bombe.

Mortar Shell. See under Granate and under Spigot Mortar Projectile.

MP-14 (Solid Catalyst) used for decomposing the T-Stoff (hydrogen peroxide) of liquid rocket propellants.
Broken porcelain pieces, previously soaked in a 50% soln of Z-Stoff (q v) and dried at 110° for 24 hours, were cooked for 10 minutes in a 50% soln of 2 parts Ca permanganate and 1 part K chromate and then redried at 110° for 24 hours.
When generating steam from T-Stoff, copper coils were mixed with MP-14 in order to accelerate initial decomposition. The ratio of catalyst to copper was about 2 to 1.
Reference: CIOS Rept 30-115 (1945), p 11.

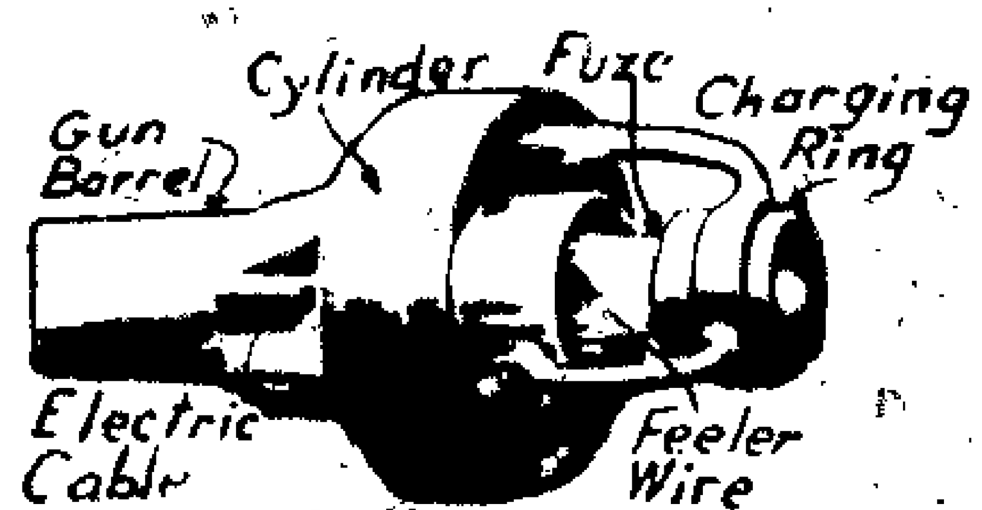
M-Stoff Commercial methyl alcohol, sp gr 0.796, used as a component of some liquid rocket fuels, such as C-Stoff (CIOS 30-115, p 10).

"Multipede". Same as Hochdruck Pumpe (High-Pressure Pump).

Munition. See Ammunition.

Mustard Pot Mine. See under Landminen.

Muzzle Charging Device, used for finer adjustment of the range of some electrical time fuzes, consisted of a cylinder which fitted around the barrel of a gun just behind the muzzle and was connected by means of an electrical cable to a battery and a voltage-control mechanism located at the breech end of the gun. A charging ring, located in front of the muzzle, was held by means of three arms placed 120° apart. These arms also served for conducting the electric current from the cylinder to the ring. When a projectile equipped with an electrical time fuze, such as the Type S/30 (El2tZ S/30), reached the muzzle, the "feeler wire" (located on the outside of the fuze and connected to



Muzzle Charging Device

its storage condenser) touched the charging ring for a short time. This resulted in the condenser of the fuze receiving an electrical charge called "vernier" charge which could range from -90 to +120 volts, depending on the voltage-control mechanism referred to above. The "vernier" charge was a supplementary charge to the initial charge of about 500 volts received by each electrical fuze prior to firing. If no vernier charge was applied, the time of burst was 16.0 seconds, but with the vernier charge the time could be adjusted between 3 to 30 seconds, depending on the voltage applied at the charging ring.
References:
1) Anon, Dept of the Army Tech Manual, TM 9-1985-3 (1953), pp 605-7
2) H.Bullock, Picatinny Arsenal; private communication.

Muzzle Flash Reduction in Propellants. See Flash Reduction in Propellants.

Myrol (Myrol). A liquid explosive consisting of a solution of methyl nitrate in methanol or other solvents. The term Myrol was also used to designate straight methyl nitrate. The material prepd prior to WW II (by cautiously dropping methanol into a mixture of nitric and sulfuric acid) proved to be impure, unstable in storage and very sensitive to heat and shock. During WW II, Walter et al (Ref 2), developed a continuous method of manufacture of methyl nitrate from methanol and dilute nitric acid, which gave a pure and much more stable product than that prepd previously. A detailed description of the method of preparation is given in Ref 2, pp 9-10. Pure methyl nitrate proved to be an explosive more powerful than NG, with a brisance exceeding any other high explosive known and with a sensitivity to shock comparable to that of PETN. Pure methyl nitrate is a clear mobile liquid with a b p of about 63° (145°F) and is insoluble in water.

Inasmuch as methyl nitrate is very sensitive to mechanical action, it was found much safer to use it in solution in methanol. Such solutions, called Myrol may be obtained directly in the process of manufacture of methyl nitrate, all that is necessary is to use an excess of methanol. One of the most suitable solns proved to be the azeotropic mixture consisting of about 75% methyl nitrate and 25% methanol. This mixture has a b p of 57.5°.

Myrols contg at least 25% methanol will not evaporate to leave hazardous 100% methyl nitrate.

Note: Römer (Ref 1) calls Myrol, the mixture consisting of 73% methyl nitrate and 27% of technical methanol containing 1% H_2O. Tschinkel (Ref 3) says that Myrol consisted of 80 weight percent methyl nitrate and 20 weight percent methanol.

Following are some properties of methyl nitrate-methanol mixtures: velocities of detonation ranging from 2400-4900 to 7500-8200 m/sec, volume of gases about 873 l/kg, heat

of explosion 1640-1700 kcal/kg, power and brisance-comparable to those of NG, sensitivity to shock-comparable to that of DNB, and toxicity-comparable to that of aliphatic nitrates, such as NG and PETN. Like NG Myrol causes headaches and pulse excitation, but they disappear more rapidly than with NG. Caffein or coffee proved most successful in decreasing pulse excitation.
References: See under Myrol Explosives.

Myrol Explosives. Methyl nitrate and its mixtures with methanol, benzene, nitrobenzene, etc found extensive application during WW II as ingredients of numerous liquid plastic and solid propellants and explosives. Some of these mixtures were known as Ersatzsprengstoffe (substitute explosives).

In the case of liquid explosives or propellants, Myrol (methyl nitrate plus methanol) was used either by itself or in mixtures with other liquids, such as benzene, MNB etc. In some cases methanol was replaced completely by benzene, MNB etc. In the case of plastic explosives or propellants, Myrol was treated with small amounts of NC to form a soft jelly. In the case of solid explosives or propellants, Myrol was treated with a large amount (25-30%) of NC to form a hard jelly, or was mixed with the usual solid ingredients of dynamites, such as kieselguhr, sawdust, inorganic nitrates, lignin, etc.

Due to the fact that Myrol is a volatile liquid, all mixtures contg it had to be kept in air-tight containers.

Several Myrol manufacturing plants were built in Germany during the 2nd half of WW II and the total capacity was as high as 20,000 metric tons per month. The largest of these plants was the Christianstadt Fabrik of Dynamit A.-G. Its capacity was 400 tons/month.

Myrol explosives were used for the following purposes:
1) Liquid Myrol mixtures were used as rocket propellants, as charges for bangalore torpedoes, land mines, bombs, special fuzes and for clearing out trenches, foxholes, etc
2) Plastic Myrol mixtures were used as military demolition charges and mining explosives
3) Solid Myrol explosives were used as bursting charges in land mines, 50 kg projector mine, hand grenades, warheads of rockets V-1 and V-2, the bursting charge of Panzerfaust (A/T shaped charge), boosters, etc.

More detailed information on Myrol Explosives and their uses follow:
A) Liquid Myrol explosives could be used for military or commercial blasting operations. When used for destroying enemy installations, rocks, etc, Myrol could be poured directly into holes or cracks, thus avoiding boring of holes. If no holes or cracks were present, they could be easily produced by exploding small demolition charges (such as in tin cans or boxes) directly on the surface of a rock, concrete etc. When used for underground work, liquid Myrol could be placed in several boxes connected by pipes (also filled with Myrol) and one end of the train detonated
B) Liquid Myrol explosives were found to be suitable for use in bangalore torpedoes
C) Liquid Myrol mixture, such as methyl nitrate 75-80 and methanol 20-25% was considered to be satisfactory as a liquid rocket fuel. Since the rate of propagation in this liquid is slow, there seems no danger that the combustion zone might run back from the combustion chamber to the supply tank. It was found that this mixture could not be exploded unless heated somewhere in the range of 200 to 300°
D) Liquid Myrol was found to be suitable for clearing out enemy trenches, foxholes, woods, etc. This clearing out operation was necessary sometimes in order to destroy mines, or other explosive or toxic devices left by the enemy. The following ingenious method, using Myrol in the form of vapor, was developed by the Germans:

A bomb provided with two fuzes, filled with Myrol and contg a small box with liquid carbon dioxide was dropped from a plane on the target. The impact of the bomb caused the first fuze to burst the box with CO_2 and to break the bomb. This caused the vaporization and distribution of the Myrol throughout the trench (or foxhole) without igniting or exploding it. The second fuze (time fuze) caused the detonation of the explosive mixture consisting of Myrol and atmospheric oxygen. With sufficiently strong initiation the following reaction has been postulated:

$$2CH_3ONO_2 + \tfrac{1}{2}O_2 = 2CO_2 + 3H_2O + N_2$$

When using this bomb in cold weather, the vapor pressure of the mixture can be increased by incorporating a small amount of methyl nitrite, CH_3ONO.
E) Liquid Myrol, or straight methyl (or ethyl) nitrate, was used in the following device developed by Staudinger:

Two small glass ampoules (bulbs), one filled with methyl nitrate (or with less volatile ethyl nitrate), and the other with metallic sodium were placed inside a fuze close to an HE filler of a land mine, but separated from it, by a thin sheet of plastic material. On top of the bulbs was placed a glass stopper. Pressure on the stopper caused crushing of the bulbs. This was followed by an explosive reaction between methyl (or ethyl) nitrate and sodium. As a result of this, the sheet of plastic was pierced and the explosive charge inside the mine or bomb detonated. Based on this principle, several land mines were developed. The smallest and simplest land mine consisted of a flask containing 80-90 g of Myrol. Through the neck of the flask was inserted a test tube reaching nearly to the bottom of the flask. An ampoule containing metallic sodium was placed in the test tube and on top of it a long plunger was carefully inserted. The pressure of this plunger caused breakage of the ampoule in the test tube thus bringing sodium in contact with the Myrol. This action caused the detonation of the Myrol in the flask. The efficiency of these small mines was sufficient to disable a motor vehicle etc. Larger mines consisted of rectangular sheet-iron boxes filled with 2kg of 88/12-Methyl nitrate/MNB mixture and used the Myrol-sodium fuze
F) Liquid Myrol explosives were also used to increase the penetrating effect of shaped charges, such as of 40/60-TNT/RDX explosive. For this, a small glass ampoule (bulb) filled with 90/10-Methyl nitrate/MNB mixture was placed in the air space (stand-off space) between the concave surface of the shaped charge and the object to be pierced, such as armor, concrete, etc. For maximum effect the initiator (fuze) should be placed at the end of charge farthest from the target and pointing towards it. For instance, in shaped-charge torpedoes, initiation of the explosive should be started from the tail end and not from the nose, as it is done in ordinary torpedoes
G) Soft jellied explosives could be obtained by incorporating 3 to 5% of NC in any of the Myrol explosives, as for instance, the ones containing MNB. These jellies could be also mixed with pulverized solids, such as sodium nitrate and/or cork powder, thus obtaining solid explosives. The solid mixtures were found suitable for filling the 50 kg projector mines. These mines exerted a strong blast effect

H) Hard jellied propellants could be prepd by incorporating in liquid Myrol (such as the ones contg 75-80% of methyl nitrate and 20-25% of methanol, or MNB) comparatively large amounts (25-30%) of nitrocellulose. Such mixtures formed very uniform hard colloids without pores or cracks and for this reason, were found to be suitable as solid rocket propellants. It is believed that some of these mixtures were used toward the end of WW II as a fuel for V-1 and V-2 rockets

Because of high volatility of Myrol, the propellent sticks used in rockets had to be coated with a special material impermeable to Myrol
I) A hard jellied explosive prepd by gelatinizing NC with a mixture of 91-95% methyl nitrate and 5-9% of MNB, was used in some boosters
J) A solid, highly brisant, explosive consisting of 30 to 40% of 75/25 Myrol mixed with such amounts of hydrated Ca nitrate and lignin that the oxygen balance was equal approximately to zero. The mixture was found suitable for filling bombs and land mines
Notes:
a) The high brisance and fairly high sensitivity to shock of the last mixture was presumed to be due to the fact that Ca nitrate extracted and bound some methanol of the mixture, thus leaving part of methyl nitrate as free sensitive droplets. Another explanation of free methyl nitrate was partial evaporation of methanol, which is more volatile than methyl nitrate. According to Dr H. Walter, Myrols vaporize in the form of azeotropic mixtures contg about 25% methanol
b) In order to prevent an excessive liberation of free methyl nitrate, it was proposed to use a solvent less volatile than methanol such as benzene or nitrobenzene. In order to prepare such a mixture, the regular Myrol, which is a mixture of 75% methyl nitrate and 25% methanol, was shaken with benzene or MNB in presence of some water. This caused the methanol to go into the aqueous layer, while methyl nitrate remained mixed with benzene or MNB.
K) A solid explosive contg 30% of a mixture consisting of 90 parts of methyl nitrate and 10 pts of benzene, plus 55% of hydrated Ca nitrate, 10% of finely pulverized aluminum and 5% of pulverized peat, had an oxygen balance equal approximately to zero. It was highly brisant and powerful, although its nitrogen content was much lower than that of TNT (14.2% vs 18.5% for TNT). This mixture was proposed as a filler for warheads in rockets V-1 and V-2
Note: Mixtures of methyl nitrate 90% with benzene 10%, do not undergo any significant change in composition in storage. The composition of Myrol mixtures may be easily and rapidly determined by checking it's refractive index
L) A solid Myrol explosive consisting of 85/15-Methyl nitrate/MNB gelatinized with NC and mixed with sawdust and hydrated Ca nitrate was suitable for use in hand grenades or in mining
M) A solid brisant explosive consisting of Myrol and a pulverized mixture of K nitrate, aluminum, and peat was suitable for hand grenades, land mines, and rock blasting.

References:
1) G.Römer, Report on Explosives, PBL Rept 85,160 (1945)
2) H.Walter et al, German Development in High Explosives, PB Rept 78,271 (1947)
3) J.G.Tschinkel, Chem Eng News 32, 2586 (1954) (Propellants for Rockets and Space Ships).

"Nashorn" (Rhinoceros). A self-propelled mount formerly known as the "Hornisse" consisting of an 88 mm A/T gun on a PzJäg III/IV or on a modified PzKpfw IV (See also under Panzer).

Natter Ba 349A. A surface-… in 1944 at the Bachem We… hydrogen peroxide/methan… carried 33 R4M rocket pro… weight 4800 lb, overall le… range 24.8 miles and max… from a vertical ramp and … ft/min.
Reference: K.W.Gatland, … Missiles, "Flight" Publicati…

Natter Ba 349B. A surface-… in 1945 at the Bachem We… hydrogen peroxide/methanol… in its nose 24 RZ 73 Föhn… weight 4,925 lbs, overall … max altitude 50,000 ft. … controlled by a radio link … ground radar.
Reference: K.W.Gatland, Dev… "Flight" Publication, London…

Nebelsäure (Fog-Acid) is … of 50/50 - Chlorosulfonic …
Reference: R.E.Richardson … p 6.

Nebelwerfer 41. See under …

Nebenschlusszünder (Shunt… in the book by Beyling-Drekop…

Needle Point Projectile. See…

Needle Projectile. See Ar… Projectile.

Neoredit. The name given … for rock blasting, up-rooting … were prepared from a surp… Hexamit, which consisted … amine) 60-70 and TNT 40-30% …
References:
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Explosives.

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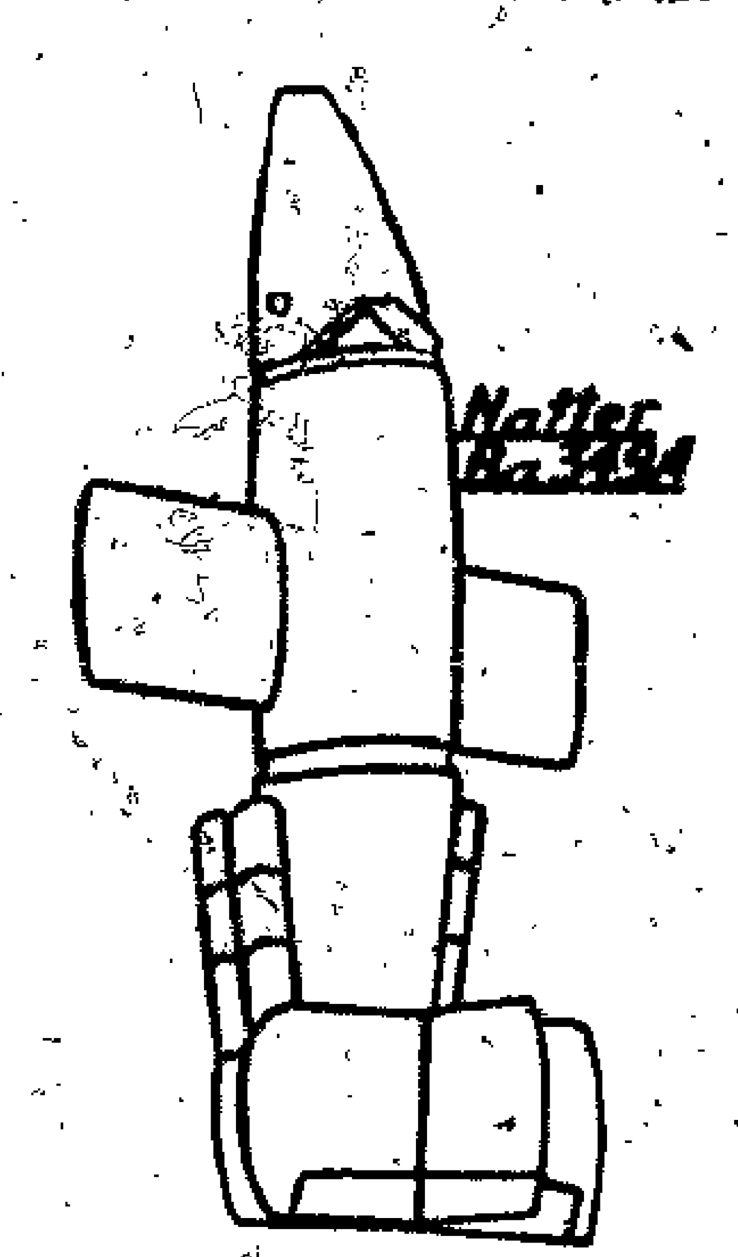
3) J.G. Tschinkel, Chem Eng News 32, 2586 (1954) (Propellants for Rockets and Space Ships).

"Nashorn" (Rhinoceros). A self-propelled mount formerly known as the "Hornisse" consisting of an 88 mm A/T gun on a PzJäg III/IV or on a modified PzKpfw IV (See also under Panzer).

Natter Ba 349A. A surface-to-air, piloted missile developed in 1944 at the Bachem Werke GmbH. It was propelled by hydrogen peroxide/methanol + hydrazine hydrate and carried 33 R4M rocket projectiles in its nose. Launching weight 4800 lb, overall length 21.25 ft, width 56.0", max range 24.8 miles and max altitude 49,400 ft. It took off from a vertical ramp and climbed at a velocity of 35,800 ft/min.
Reference: K.W. Gatland, Development of the Guided Missiles, "Flight" Publication, London (1952), pp 10 & 114-15.



Natter Ba 349B. A surface-to-air, piloted missile developed in 1945 at the Bachem Werke GmbH. It was propelled by hydrogen peroxide/methanol + hydrazine hydrate and carried in its nose 24 RZ 73 Föhn (q v) rocket projectiles. Launch-weight 4,925 lbs, overall length 20.6 ft, width 36.0", and max altitude 50,000 ft. It was launched vertically and controlled by a radio link to the pilot in conjunction with ground radar.
Reference: K.W. Gatland, Development of the Guided Missile, "Flight" Publication, London (1952) pp 114-5.

Nebelsäure (Fog Acid) is a smoke-screen agent consisting of 50/50 - Chlorosulfonic acid/Sulfur trioxide (by weight)
Reference: R.E. Richardson et al, CIOS Rept 25-18 (1945), p 6.

Nebelwerfer 41. See under Rocket Launchers.

Nebenschlusszünder (Shunt-Circuit Igniter) is described in the book by Beyling-Drekopf (1936), p 216.

Needle Point Projectile. See Arrowhead Projectile.

Needle Projectile. See Arrow Projectile and also Grenner Projectile.

Neoredit. The name given after WW I to explosives used for rock blasting, up-rooting stumps, etc. These explosives were prepared from a surplus military explosive called Hexamit, which consisted of Hexamin (hexanitrodiphenylamine) 60-70 and TNT 40-30%.
Reference:
P. Naoúm, Schiess- und Sprengstoffe, Dresden (1927), p 71.

Neudehmenit (New Dehmenite). One of the earlier permissible mining explosives: Am nitrate 68, TNT 10, flour 2.5, K nitrate 2.0, Na chloride 15.5, and coke dust 2.0% [Colver, (1918) p 249].

Neudynamit - Austrian name for Gelatin Dynamite.

Neunkirchen Testing Gallery (Schlagwetter-Versuchsstrecke in Neunkirchen). See general section under Galleries, Testing and A.Stettbacher, Schiess- und Sprengstoffe, p 248.

Neu-Nobelit (New Nobelite). A class of permissible explosives used before and after WW I. Table 27 gives some examples.

Table 27

Composition (%) and some properties	New-Nobelites					
	1	12	14	15	16	C
Am nitrate	27.0	36.0	30.5	54.0	54.0	50.0
NG + NC jelly	26.0	30.0	30.0	12.0	12.0	12.0
Glycerin	-	-	-	-	-	4.0
Gum-sugar	-	3.5	-	-	-	-
Cereal meal	9.0	-	6.4	-	-	6.0
Wood meal	1.0	-	-	4.0	3.0	--
Nitrocompounds	-	-	-	2.0	3.0	-
Na nitrate	-	-	-	-	-	3.0
Alkali chloride	29.0	30.5	33.1	28.0	28.0	20.0
DNT	8.0	-	-	-	-	-
Talc	-	-	-	-	-	5.0
Oxygen Balance, %	-14.9	+4.6	-1.6	+0.6	+2.8	-0.6
Trauzl Test, cc	230	220	230	225	225	220
Pb Block Crushing, mm	-	-	-	-	13.0	-
Velocity of Detonation, m/sec	-	-	-	-	4600	-
Density of Cartridge	-	-	-	-	1.20	-
Sensitiveness to Initiation, Requires at least:	-	-	-	-	No 1 cap	-
Gap Test, cm	-	-	-	-	25	-
Heat of Explosion, kcal/kg	-	-	-	-	643	-

(See also Nobelit).

Reference:
P.Naoúm, Nitroglycerin, etc, Baltimore (1928), pp 411, 441 and 444.

Neuwestfalit (New Westphalite) One of the permissible explosives used after WW I: Am nitrate 70.3, DNT 10.9, flour 2.0, and Na chloride 16.8%; Trauzl Test 309 cc.

References:
1) Marshall, v 1 (1917), p 391 2) Barnett (1919), p 138.

Nigu. German abbreviation for Nitroguanidin, also called "G-Salz". Abbreviation used in this book is NGu.

Nipolit (Nipolite) A type of NC-DEGDN-PETN propellant or explosive, developed during WW II at the Kraiburg plant of the Deutsche Sprengchemie GmbH. The following compositions are listed in Refs 2, 3 & 4 (See Table 27a).

TABLE 27a

Composition (%) and dimensions	Nipolit tubes	Nipolit Sticks
NC(12.6-12.7% N)	34.1	29.1
DEGDN	30.0	20.0
PETN (unwaxed)	35.0	50.0
Stabilizer	0.75	0.75
MgO	0.05	0.05
Graphite	0.1	0.1
Length of grain	80 mm	50 mm
Diameter of grain	27 mm	9.1 mm
Hole Diameter	9.1 mm	—
Hole Depth	30 mm	--
Weight of grain	42 g	—
Calorific value, cal/g	1300	—

Note: MgO was added to neutralize acid developed on decomposition, and graphite was added to prevent the accumulation of hazardous static electrical charges.

For the preparation of Nipolit, a water slurry of NC was air-agitated in a lead-lined vessel, with the desired amount of DEGDN. After 15-20 minutes stirring the mass was centrifuged to remove all but about 25% of water and the resulting cake was kneaded, at about 50°C, in a Werner-Pfleiderer machine with the calculated amount of pulverized PETN, some water, stabilizer, MgO and graphite. After about 15 minutes of kneading the mass (paste) was transferred to rubber lined bags where it was allowed to age for 48-72 hours.

Notes:
a) According to Ref 4, all raw materials with the exception of PETN were added in the paste mixing stage, while PETN was added during incorporation
b) It was claimed that the aging process insured better gelatinization and reduced the tendency to fire during the rolling operation which followed
c) The calorific value of the materials was carefully adjusted to between +30 and -10 calories as permissible variation from specification value for the propellant being processed. If outside these limits, the material was returned to the mixers and the calorific value either reduced by adding centralite or hydrocellulose or increased by adding wet paste consisting of NC and DEGDN. Each mixer was sampled at least every 8 hours. For a total charge of 18 kg a maximum of 3 kg of rework material was permitted

Rolling and granulation were carried out as follows:
About 18 kg of the aged paste was passed, about 15-20 times, through a pair of vertical rolls maintained at 90-100° (Ref 3).
Note: According to Ref 4 rolling was conducted at a temperature not higher than 75°C.

The resulting sheet (moisture content about 3%), was made by hand into a carpet roll and transferred to the press-house where it was kept in a steam heated oven, prior to transfer to the extrusion press. Then the mass was extruded at a pressure of 200 kg/cm² and at a temperature of about 80° and the resulting tubes (or sticks) cut into desired lengths.

After drying the cut material for about 24 hours at 40-50°, the moisture content was reduced to about 1%.

The next operation consisted of wetting each stick of Nipolit with acetone and pushing the stick into a tube of Nipolit flush with one end. This left a cavity 30 mm long in each tube to accomodate a detonator. The stick Nipolit (core) acted as a booster.

References:
1) D.W.Stickland et al, PB Report 1820 (1945), p 38
2) A.A.Swanson & D.D.Sager, CIOS Report 29-24 (about 1946), pp 3-4
3) T.Urbański, Przemysł Chemiczny 27(4), 487-94 (1948) C A 43, 4465 (1949) "Recent Development in the Field of Explosives" (Translated by Dr Ivan Simon of Arthur D. Little Inc)
4) A.A.Swanson, D.D.Sager & L.M.Sheldon, Ordnance Target Report No 88 (Spec Rept No 2071); Manufacture of Solventless Type Powder and Nipolit by the Deutsche Sprengchemie, Kraiburg Wks.

Nitric Acid (Salpetersäure). Its preparation, properties and uses are described in the general section. Nitric acid was produced in Germany during WW II, mostly by the ammonia oxidation process, in quantities exceeding 140,000 tons per year. In addition, there was also available the 17,000 tons produced in occupied Austria, Czechoslovakia and Poland.

For the manufacture of highly concentrated (hochkonzentrierte) nitric acid, the so-called "Hoko" (q v) process was developed.

Production of nitric acid in Germany was controlled by the Stickstoff-Syndikat.

Following is a partial list of the principal producers of nitric acid in the Western Zone of Germany:
a) Badische Anilin- und Sodafabrik A -G, Oppau (formerly IG Farbenind A -G)
b) Bergwerkgesellschaft Hibernia, A -G, Herne, Stickstoffwerke, Wanne-Eickel
c) Chemische Fabrik Kalk GmbH, Köln-Kalk (Founded in 1857).
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e) Farbwerke Höchst, bei Frankfurt a/Main (formerly IG Farbenind A -G)
f) Gewerkschaft Victor Chemische Werke, Castrop-Rauxel 2, Westfalien
g) IG Farbenindustrie A -G with plants at Leverkusen (formerly Fried Bayer & Co), Bochum-Gerthe, Ruhr (later called Chemische Werke Lothringen GmbH) (was founded in 1916) and Herne-Sodingen, Ruhr (formerly GAVEG)
h) Ruhrchemie A -G, Oberhausen -Holten, Ruhr (founded in 1927 under the name of Kohlenchemie A -G)
i) Wirtschaftliche Forschungs GmbH (WIFO) with plants at Embsen, Kr Lüneburg (founded in 1939-1940) and at Langelsheim, Harz (founded in 1939).

According to Ref 3 the following plants in the Eastern Zone were dismantled and shipped to Poland or Russia:
j) Christianstadt a/d Bober, Brandenburg (Dynamit A -G)
k) Bitterfeld South (described in Ref 1)
l) Döberitz
m) Heydebreck
n) Leuna
o) Piesteritz (Bayerische Stickstoff A -G)
p) Sondershausen
r) Wolfen (described in Ref 1)

References:
1) R.J.Morley, BIOS Final Rept 889, Item 22 (1946)
2) W.Kenworthy & F.R.Dell, BIOS Final Rept 1232, Items 22 & 31 (1946)
3) F.M.Irvine et al, BIOS Final Rept 1442, Item 22 (1946).

Nitrobaronit (Nitrobaronite). An early type of aluminized explosive. The following mixtures, described by L.Médard, Mém Artil Fr 22, 596 (1948) are given in Table 28.

Table 28

Composition (%) and some properties	Nitrobaronite A	Nitrobaronite B
Aluminum	5.0	2.0
Am nitrate	82.0	69.0
Nitroglycerin	5.0	22.0
Collodion cotton	-	0.75
Liquid DNT	5.0	3.0
Petroleum tar	1.5	2.0
Wood meal	1.5	1.25
Pb Block Expansion (Picric acid = 100) (See "C u p" in the French Section)	124.0	125.5

Nitrocellulose, Nitrozellulose oder … abbreviated in German to Nz (Nitroce… in this work to NC). See general secti…

Due to the absence of native cotto… nitrocellulose was prepared from wood p… Following is a brief description of the … WW II at the Krümmel Fabrik of D… Refs 1 & 2:

a) Bleached cellulose in the form o… from wood pulp), was broken down … into flocks and then blown into la… where the moisture content was re… 1-2%

b) 25 kg of cellulose flocks wer… into a nitrator of 0.7 m³ capacity… of mixed acid (MA), prepd by forti… (SA) from previous batches.

Note: For NC of 11.25-11.50% N, ca… MA consisted of 20% nitric, 62-64% … water; for NC of 13.2-13.3% N, calle… composition of MA was 22.5% nitric, 67.5… 9-10% water. The time of nitration w… the temperature 30°.

c) The contents of the nitrator w… centrifuge (one for every 4 nitrato… minutes at 900 rpm

d) The separated spent acid (SA… filter drums where the small 'to… were separated and then to the fortifi…

e) The NC which was removed from … the filters was carried by a stream … washers where the bulk of the ac… stirring with water

f) The slurry was then pumped to a… vessel provided with a double b… upper one was false, consisting … which the wash water was allowed… end of the boiling period. Boiling … atmospheric pressure: 3 hours for … hours for Schiesswolle

g) After removing the acid water, … by a stream of water into the pre… where the material was cooked for … less steel autoclaves, starting at … at 142-145°.

Note: Pressure cooking had a double … the viscosity of NC, to the desired le… up the stabilization. The details of th… varied from plant to plant.

h) A sample of cooked NC was sent t… if the viscosity of the NC (as de… method in a 3% acetonic soln) was… range, the charge was dropped into … such as the Hollander or Banning… NC was beaten for several hours, … slurry was maintained between 7 an… periodically. It usually required 3 to 4…

i) The pulped NC plus water was p… rotating sieves where more water w… smaller particles of NC passed thr… while the latter particles were retai… larger particles were removed by … pulped, while the slurry of smaller … dewatering device (rotating drum siev…

j) The dewatered small-particle mat…

TABLE 27a

Composition (%) and dimensions	Nipolit tubes	Nipolit Sticks
NC(12.6-12.7% N)	34.1	29.1
DEGDN	30.0	20.0
PETN (unwaxed)	35.0	50.0
Stabilizer	0.75	0.75
MgO	0.05	0.05
Graphite	0.1	0.1
Length of grain	80 mm	50 mm
Diameter of grain	27 mm	9.1 mm
Hole Diameter	9.1 mm	—
Hole Depth	30 mm	--
Weight of grain	42 g	—
Calorific value, cal/g	1300	—

Note: MgO was added to neutralize acid developed on decomposition, and graphite was added to prevent the accumulation of hazardous static electrical charges.

For the preparation of Nipolit, a water slurry of NC was air-agitated in a lead-lined vessel, with the desired amount of DEGDN. After 15-20 minutes stirring the mass was centrifuged to remove all but about 25% of water and the resulting cake was kneaded, at about 50°C, in a Werner-Pfleiderer machine with the calculated amount of pulverized PETN, some water, stabilizer, MgO and graphite. After about 15 minutes of kneading the mass (paste) was transferred to rubber lined bags where it was allowed to age for 48-72 hours.

Notes:

a) According to Ref 4, all raw materials with the exception of PETN were added in the paste mixing stage, while PETN was added during incorporation

b) It was claimed that the aging process insured better gelatinization and reduced the tendency to fire during the rolling operation which followed

c) The calorific value of the materials was carefully adjusted to between +30 and -10 calories as permissible variation from specification value for the propellant being processed. If outside these limits, the material was returned to the mixers and the calorific value either reduced by adding centralite or hydrocellulose or increased by adding wet paste consisting of NC and DEGDN. Each mixer was sampled at least every 8 hours. For a total charge of 18 kg a maximum of 3 kg of rework material was permitted

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Nitrocellulose, Nitrozellulose oder Schiessbaumwolle, abbreviated in German to Nz (Nitrocellulose, abbreviated in this work to NC). See general section under Cellulose.

Due to the absence of native cotton in Germany, their nitrocellulose was prepared from wood pulp.

Following is a brief description of the method used during WW II at the Krümmel Fabrik of D A-G, as given in Refs 1 & 2:

a) Bleached cellulose in the form of crêpe paper (made from wood pulp), was broken down in special machines into flocks and then blown into large drying chambers where the moisture content was reduced from 6-7% to 1-2%

b) 25 kg of cellulose flocks were fed with stirring into a nitrator of 0.7 m^3 capacity containing 1125 kg of mixed acid (MA), prepd by fortifying the spent acid (SA) from previous batches.

Note: For NC of 11.25-11.50% N, called PE-Wolle, the MA consisted of 20% nitric, 62-64% sulfuric and 16-18% water; for NC of 13.2-13.3% N, called Schiesswolle, the composition of MA was 22.5% nitric, 67.5-68.5% sulfuric and 9-10% water. The time of nitration was 30 minutes and the temperature 30°.

c) The contents of the nitrator were emptied into a centrifuge (one for every 4 nitrators) and spun for 6 minutes at 900 rpm

d) The separated spent acid (SA) went to rotating filter drums where the small torn particles of NC were separated and then to the fortifier.

e) The NC which was removed from the centrifuges and the filters was carried by a stream of water into pre-washers where the bulk of the acid was removed by stirring with water

f) The slurry was then pumped to a preliminary boiling vessel provided with a double bottom of which the upper one was false, consisting of a screen through which the wash water was allowed to flow off at the end of the boiling period. Boiling was carried out at atmospheric pressure: 3 hours for PE-Wolle and 6-8 hours for Schiesswolle

g) After removing the acid water, the NC was carried by a stream of water into the pressure boiling plant, where the material was cooked for 6 minutes in stainless steel autoclaves, starting at 100° and finishing at 142-145°.

Note: Pressure cooking had a double purpose: it reduced the viscosity of NC, to the desired level and it speeded up the stabilization. The details of the pressure cooking varied from plant to plant.

h) A sample of cooked NC was sent to the laboratory and if the viscosity of the NC (as detnd by the Höppler method in a 3% acetonic soln) was within the desired range, the charge was dropped into a pulping machine such as the Hollander or Banning-Seybold. Here the NC was beaten for several hours, while the pH of the slurry was maintained between 7 and 9 by adding soda periodically. It usually required 3 to 4 kg of soda.

i) The pulped NC plus water was pumped into vertical rotating sieves where more water was added. Here the smaller particles of NC passed through a 0.4 mm sieve while the latter particles were retained by it. Then the larger particles were removed by scrapers to be repulped, while the slurry of smaller particles went to a dewatering device (rotating drum sieve)

j) The dewatered small-particle material was transferred

to a final stabilizer consisting of a cylindrical vessel where the NC was treated with live steam until the slurry was brought to a boil. Then the water was decanted, the NC washed with water and a sample sent to the laboratory. In case of collodion cotton (PE-Wolle), the above treatment was usually sufficient and the material would pass the Bergmann-Junk Test (Heating for 2 hours at 132° C should not produce more than 2 ml of NO per 1 g of PE-Wolle)

k) If the material was guncotton (Schiesswolle) the above treatment was not sufficient and heating had to be continued until a satisfactory B-J Test value was obtained (Not more than 2.5 cc NO per 1 g of Schiesswolle)

l) In order to obtain NC of the desired N content and viscosity, several batches were blended in large vats provided with stirrers. The blended material was then stirred with a large quantity of water and run through grit traps.

Note: Grit traps were round vessels, conical at the base. The slurry entered from below and its velocity decreased as it flowed upward (due to the increase in diameter of the of the vessel) to such an extent that all the heavier particles (such as grit or dirt) dropped to the lower part of the vessel while the particles of NC continued to travel upward

m) After "de-gritting", the slurry was thickened up by passing it through a dewatering rotating drum for final dewatering. The partly dewatered material was sent to a centrifuge where it was spun at 1000 rpm

n) The resulting NC was shovelled into a zinc-lined iron container (provided with a cover), where it was weighed, labelled and dispatched either to propellent plants or to a plant manufacturing "Rohpulvermasse" (Raw Paste)

o) As the waste waters from the manufacture of NC contained an appreciable amount of suspended small particles of NC, it was required that these particles be removed before the water was allowed to leave the plant site. One method was to allow the water to run through so-called Dunsch traps. These were conical vessels with the narrow part at the bottom. The water flowed from the bottom upward; as the area of the vessel increased, the velocity of flow was reduced to such an extent that the suspended particles settled. The accumulated fines were periodically removed from the vessel.

Note: In many German propellants that were examined at Picatinny Arsenal during WW II, the nitrogen content of the NC was around 12±0.2%, which means that the NC was intermediate between the PE-Wolle and Schiesswolle. One of the DEGDN propellants contained NC with N=10.3% (See under Propellants).

Stettbacher (Ref 3) describes briefly various methods of manufacture of NC and gives compositions of mixed acids used for the preparation of NC with nitrogen contents of 11.6, 12.5, 12.75, 13.2, 13.4 and 13.7%. Yields and solubilities of various nitrocelluloses in 3/1-ether/alcohol mixture are also given.

References:

1) O.W.Stickland et al, General Summary of Explosives Plants, PB Rept 925 (1945), pp 50-55)

2) Lee Nutting et al, Manufacture of NC at the Krümmel Plant of the Dynamit A -G , PB Rept 16,666 (1945)

3) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948) pp 62-66.

Nitrocellulosepulver (Nitrocellulose Propellant or Single-Base Propellant). See under *Propellant*.

Nitrochlorin. A low-freezing explosive oil used in the manufacture of some dynamites. It consisted of 80% dinitrochlorohydrin and 20% NG and was prepared by nitration of commercial monochlorohydrin containing glycerin. [P.Naoúm, Schiess- und Sprengstoffe (1927), p 113].

Nitroform or Trinitromethane, described in the general section, was prepared and investigated during WW II in Germany by Dr Schimmelschmidt. He recommended the preparation of nitroform from tetranitromethane, potassium hydroxide and hydrogen peroxide, according to the following reaction:

$$C(NO_2)_4 + 2KOH + H_2O_2 = (NO_2)_3CK + KNO_2 + O_2 + 2H_2O$$

His preference for the above method was based on the claim that the method previously suggested by Orton and McKee, depending on the reaction between tetranitromethane, K hydroxide and hydrazine, is hazardous since, in addition to K salt of nitroform, hydrazoic acid and not nitrogen (as was previously believed), is formed.

Nitroform was liberated from its K salt by distillation at reduced pressure in the presence of sulfuric acid. The resulting product had a m p of 26.4° as against 22° obtained by some previous investigators.

Dr Schimmelschmidt also found that nitroform may be extracted from the reaction product of acetylene and nitric acid using liquid nitrogen dioxide at 0° as a solvent. This method of nitroform recovery was considered to be of great importance, since the product so obtained could be converted to tetranitromethane using only a small amount of sulfuric acid (See also under Tetranitromethane).

Note: Due to the shortage of sulfuric acid, which developed in Germany during WW II, any substance which could be used in place of sulfuric acid was considered highly desirable. For this reason, the use of liquid nitrogen dioxide was proposed also for the extraction of other nitrocompounds, in addition to nitroform.

Nitroform was found to be an excellent rust inhibitor when incorporated in polyvinyl acetate emulsions and also was found to be superior to Na nitrite in that it did not destroy the emulsion.

In the course of the investigation of the reactions between nitroform and organic compounds Dr Schimmelschmidt obtained several substances which were highly explosive, as for instance:

a) On treating nitroform with vinyl-methyl ketone, the following reaction took place:

$$CH_2{:}CH{\cdot}CO{\cdot}CH_3 + CH(NO_2)_3 \rightarrow (O_2N)_3C{\cdot}CH_2{\cdot}CH_2{\cdot}COCH_3$$

The resulting Trinitropropylmethyl Ketone was an explosive comparable in power to RDX

b) When a stream of acetylene was bubbled through nitroform containing a little mercuric nitrate the following reaction took place:

$$HC{\vdots}CH + CH(NO_2)_3 \rightarrow CH_2{:}CH{\cdot}C(NO_2)_3$$

Interaction of this compound with nitroform gave an extremely powerful explosive, believed to be a mixture of 1,4-Di(trinitro)butane and Hexanitroisobutane:

$$CH_2{:}CH{\cdot}C(NO_2)_3 + CH(NO_2)_3 \rightarrow CH_3{\cdot}CH\begin{matrix}\diagup C(NO_2)_3\\ \diagdown C(NO_2)_3\end{matrix}$$

$$\downarrow$$

$$(O_2N)_3C{\cdot}CH_2{\cdot}CH_2{\cdot}C(NO_2)_3$$

c) Reaction of nitroform with formaldehyde gave Trinitroethanol:

$$HCHO + CH(NO_2)_3 \rightarrow CH_2OH{\cdot}C(NO_2)_3$$

Reference: W.Hunter, BIOS Final Rept 709 (1946), pp 2 & 6 - 10.

Nitrogelatine picrique. Under this title J.Daniel, Dictionnaire des Matières Explosives, Paris (1902), p 523 described an explosive, consisting of NG+NC jelly mixed with about 10% of picric acid. This mixture, patented in 1887 by the Deutsche Sprengstoff Gesellschaft of Hamburg, did not prove to be very stable.

Nitroglycerin und Nitroglykol (Nitroglycerin and Nitroglycol, abbreviated in this work to NG and NGc). The manufacture and properties of these substances are described in the general section under Glycerin and Glycol, respectively.

In Germany the nitration of glycerin or of glycol (ethyleneglycol) was conducted either by a batch process or by a continuous method, such as that of Schmid, Meissner or Biazzi. The nitration was made either separately for glycerin and glycol, or more often as mixtures, such as glycerin 60 and glycol 40%.

The batch method of nitration of glycerin, or of glycol or of their mixtures at the Krümmel Fabrik Dynamit A -G may be given as an example:

a) 300 kg of glycerin was run into 1470 kg of mixed acid, consisting of HNO_3 50, H_2SO_4 52 and H_2O-2%, contd in a stainless steel nitrator which was provided with an air stirrer and cooling coils

b) In order to maintain the mixture in the nitrator at about room temperature, the brine, cooled to as low as -12° was circulated through coils

c) After about 25 minutes of nitration, the air agitation was stopped and the mixture allowed to stand. In order to accelerate the separation of the nitration products, 70 g of an 80/20 mixture of Na flouride and of ignited kieselguhr was added

d) The separated oil was air-stirred at 12° with 400 liters of water and after removal of the water, the oil was air-stirred for 12 minutes at 40° with 500 l of 2% soda ash soln

e) After cooling the mixture to 28°, while still continuing to stir, 50 g of pulverized talc was added and then the mass was allowed to stand

f) The separated oil was run through a pipe which ended some distance short of the storage tank. From that end of the pipe, the oil was transported to the tank by means of hand trucks

g) The spent acid, which in the case of NG weighed about 1200 kg and had the approx compn: HNO_3 7.5, H_2SO_4 75 and H_2O 17.5%; and in the case of NGc (nitroglycol) weighed about 1030 kg and had the approx compn: HNO_3 8.5, H_2SO_4 74.5 and H_2O 17%, from which the bulk of oil had been removed, was allowed to stand for several days in lead-lined vessels, called "After-Separators". The separated oil was washed in a small auxiliary vessel first with water and then with 2% soda ash solution.

Note: The total yield of oil was reported to be about 233 parts per 100 of glycerin. Other plants reported yields ranging from 231 to 234, and for NGc 230.

h) The spent acid of (g), was blown by compressed air to a tank and from there to a separator in order to recover some more of the explosive oil. Then the acid was transferred to the Recovery Plant where the nitric acid was distilled off, leaving weak sulfuric acid as a residue

i) As the waste wash waters of operations (d) and (g) contained small amounts of oils (NG, or NGc) it was necessary to remove the oils before allowing the waters to run into a stream, lake, etc. This was accomplished by allowing the waters to run through large settling tanks, sometimes installed in cascade form

j) In order to economize on the consumption of nitric acid and to prevent poisoning of personnel all nitric acid fumes (as well as nitrogen oxide gases) were drawn from both the nitrator and separator by means of a suction device and led to an absorption tower in which they were met by a spray of water to dissolve them and form nitric and nitrous acids

k) A sample of washed oil [see operations (d) and (g)] was sent to the laboratory for testing. The Abel test at 82° was usually about 40 minutes.

Note: The results of the Abel Test were usually higher than in the U S practice. The high German results are presumably due to the fact that talcum was used in the separation of the oil [see operation (e)]. The Americans do not use talcum to improve the separation of NG or of NGc from spent acids.

The Sythen Fabrik of W A S A -G also used the batch process, while the Schlebusch Fabrik of Dynamit A -G had three different NG installations:

a) Batch plant

b) Continuous plant with Meissner nitrator and Biazzi separators and washers

c) Continuous plant with Biazzi nitrator, separators and washers, installed by Mario Biazzi, Switzerland.

In the Biazzi installation, which had an output of 800 to 1000 kg per hour, the nitrator was a cylindrical stainless steel vessel approximately 2 ft in diameter by 8 ft 6 in deep (See Fig. 1, p A2/9 of Ref 5). Cooling was carried out by running chilled brine through a series of six concentric coils suspended inside the nitrating vessel. Stirring was carried out with a mechanical stirrer situated in the center of the inner cooling coil and running at about 400 rpm. A tangential separator was placed about 2 ft below the level of the outlet of the nitrator and a 2nd separator followed the 1st. The mixed acid used in the nitration was approximately 50/50-nitric acid/sulfuric acid, stored in a tank for at least 10 days and then passed through a stainless steel gauze before use.

Procedure:

a) The mixed acid, 5 parts, and glycerin (or glycol, or glycerin plus glycol) 1 part, each metered by means of a rotameter, entered continuously and simultaneously, the lower part of the nitrator

b) The emulsion consisting of nitrated product (oil) and spent acid left the nitrator and was run straight to a tangential separator placed about 2 ft below the level of the outlet from the nitrator

c) The separated acidic oil went to a stainless steel vessel 1½ ft in diameter and 2 ft deep, provided with a mechanical stirrer, where the oil was washed with an equal volume of water, while the spent acid (which in case of NG, had the approximate composition: HNO_3 11, H_2SO_4 73.5, H_2O 14 and NG 1.5%) went to a special lead separator, called Scheider. This operation permitted the removal of some additional oil before the acid was fortified to be reused for nitration of the next bath, or before the acid was sent to the recovery plant

d) After pre-washing the oil with water, the emulsion flowed continuously into a tangential separator from which the separated oil went to the next part of the process

e) The acidic water (which in the case of NG had the approximate composition: HNO_3 10.6, H_2SO_4 1.1, H_2O 87.6 and NG 0.7%) went to another separator outside a mound surrounding the nitrating house where some oil was recovered

f) The pre-washed oil of the operation (d) went through two vessels in series, each of them equipped with a stirrer. Simultaneously with the oil a 15% soda ash

solution, measured by a rotameter, entered the vessels. There was no separation of the emulsion between these vessels, and the oil/soda emulsion went from them to an annex (wash-house), located outside the mound surrounding the nitrating house.

Note: All the above listed operations were conducted in the nitrating house. It should be mentioned that the nitrator was provided on the bottom with a glass plate which could be broken when it was required to drown a charge. A pneumatic hammer operated by a handle at the door of the building was used for breaking the glass. The drowning tank, located below the nitrator, contained about 5 times the volume of the nitrator of 95% sulfuric acid.

g) The emulsion from the previous operation went through two separators located in the wash house. The separator oil was collected in a rubber lined aluminum truck, holding 600 kg, while the wash waters went via a cascade system to a tunnel leading to the Rhine River

h) The truck contg neutralized oil was emptied into a storage tank where it was allowed to stay for at least one day to permit the water to separate.

Note: In a newer type of final settling house, there were ~~6 Biazzi tangential lead separators placed in cascade and~~ working continuously.

i) The dried oil was removed from the storage tank as needed, by means of heavy rubber buckets of 40 kg capacity.

The average yield of dry NG from the Biazzi plant was 232 parts by weight per 100 pts of dry glycerol. The stability was 14 minutes by the Abel Test at 81°. When the nitrating acid was made from acids recovered from TNT manufacture, it was sometimes necessary (in order to obtain satisfactory stability for NG) to include from 0.1 to 0.2% of Na sulfite in the soda washing liquor. During the war, however, diphenylamine stabilizers were sometimes used when the quality of the NG was unsatisfactory.

In the manufacture of double-base propellants, NG was used alone, while in the manufacture of commercial dynamite-type explosives it was used in mixtures with NGc (nitroglycol).

References:

1) R.Escales, Nitroglyzerin und Dynamit, Veit, Leipzig (1908)
2) P.Naoúm Nitroglycerin and Nitroglycerin Explosives, Williams & Wilkins, Baltimore, 1928) pp 25-178 & 210-239
3) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig, (1933), pp 146-172
4) O.W.Stickland et al, General Summary of Explosive Plants, PB Rept 925 (1945), pp 67-8
5) R.Ashcroft et al, Investigation of German Commercial Explosives, B I O S, Final Rept 833, Item 3, H M S O, London (1946), pp A 1/4 and A 2/4
6) A.Stettbacher, Spreng- und Schiesstoffe, Zürich, (1948), pp 59-62.

Nitroglycerin-Nitrocellulose Explosives. Commercial explosives suitable for blasting rocks were prepared by mixing double-base propellants (left as surplus after the termination of WW I) with other ingredients, such as inorganic nitrates and organic nitrocompounds.

Following are the compositions of some of these explosives:

a) Mining List No 33 Explosive: NG 30 to 40, NC 60 to 70, with added 0 to 5% of nitroderivatives of toluene (and/or naphthalene) and 0 to 10% of paraffin (and/or urethane, and/or centralite, and/or dicyandiamide)

b) Mining List No 35 Explosive: NG+NC jelly 94 to 96 and 4 to 6% of a 50% aqueous solution of Ca nitrate

c) Mining List No 36 Explosive: NG+NC jelly 97 to 99, and 1 to 3% of substituted urethanes.

References:

1) P.Naoúm, Nitroglycerin etc, Baltimore (1928), pp 449-50
2) J.Pepin Lehalleur, Poudres, etc, Paris (1935), p 458.

Nitroglycerinsprengstoff (Nitroglycerin Explosive). See Dynamit.

Nitroglycerinpulver (Nitroglycerin Propellant). A propellant based on NC and NG, also called double-base propellant. Prepn and properties of typical NG propellants are given in the book of A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 41-43

See also under Propellants.

Nitroglykol (Nitroglycol), abbreviated in this book to NGc is described in the general section under Glycol. The manufacture of NGc in Germany was conducted in the same manner as for NG. Because of high volatility, it is not advisable to use NGc alone in explosive compositions (although the Germans sometimes did), but it is satisfactory to add NGc to NG in order to depress the freezing point of the latter. Such mixtures were used extensively in the preparation of commercial dynamite-type explosives.

References: Same as under Nitroglycerin.

Nitroguanidin (Nigu) [Nitroguanidine (NGu)], described in the general section under Guanidine was prepd in Germany by treating guanidine nitrate (GuN) with concd sulfuric acid as described by Schnurr (Ref 4).

Briefly, the method was as follows:

In order to obtain 100 kg of NGu, 135 kg of GuN was added gradually to 300 kg of 98% sulfuric acid while stirring and cooling so that the temperature was not allowed to go above 45°. The resulting mixture was run into a dilution vessel (maintained at 0°) in which the precipitation of the crude NGu took place. By using a centrifuge, the crude product was separated from the liquid phase which contained about 20% H_2SO_4. The crude material was dissolved in boiling water, mixed with the mother liquor from the previous batch (see below), made exactly neutral by means of ammonia, filtered and the filtrate cooled to at least 45° at low pressure. The resulting crystalline suspension was transferred by air pressure to a centrifuge. This gave purified NGu with a water content of about 6% and a mother liquor which was later used for dissolving the crude NGu of the next batch (see above) (Ref 4).

The preparation of NGu was also described by Stettbacher (Ref 1).

Uses of NGu:

A) According to Davis (Ref 2), NGu in admixture with Am nitrate and wax or paraffin was used during WW I for loading various bombs. These compositions were fairly insensitive to shock

B) During WW II NGu was used either in propellants such as the cool, erosionless and flashless triple-base propellant, called Gudolpulver, or in explosive compositions.

Note: When intended for use in propellants, the NGu crystals were required to be of such size and shape that when the ingredients of a propellant were rolled into sheets, the

incorporation was smooth and rapid. When intended for use in explosives, two kinds of NGu crystals were used:

a) finest grain crystals (dust) obtained by rapidly evaporating a hot aqueous solution of NGu under high vacuum. These crystals were found to be suitable for press-loading

b) crystals with high bulk density (above 1.0), obtained by crystallizing NGu in the presence of colloids. Such crystals were found to be suitable for the cast-loading of TNT-NGu mixtures

C) As an example of the uses of NGu as a high explosive may be cited the 1800 kg AP bomb in which some NGu was placed in the nose as a sort of protection (bumper) for the more sensitive main charge consisting of "Filler 109".

Note: According to CIOS Rept 32-68 (1945), German production of NGu towards the end of WW II was about 1500 tons per month.

References:

1) A.Stettbacher, Nitrocellulose 7, 141-145 (1936) (Nitroguanidin)
2) T.L.Davis, Army Ordnance 20, 93 (1939)
3) PB Rept 925 (1945), pp 22 & 116
4) W.Schnurr, PB Rept 16 665 (1945)
5) Allied and Enemy Explosives, Aberdeen Proving Ground, Md (1946), p 149
6) A.Stettbacher, Spreng- und Schiesstoffe (1948), p 44.

Nitroisobutylglycerintrinitrat (Nitroisobutylglycerin Trinitrate). See general section and also A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 69.

Nitrol. See general section,

Nitrolit. An amatol type explosive in which TNAns (trinitroanisole) was used to replace TNT. The mixture of TNAns 60 and Am nitrate 40% was of light yellow color with a m p about 75° which permitted cast-loading. Its strength, brisance and sensitivity to mechanical action were similar to those of 40/60 Amatol. It was hygroscopic and in the presence of moisture the TNAns hydrolyzed to picric acid, which would attack metals with the formation of dangerous picrates, while the Am nitrate could hydrolyze to form ammonia. Nitrolit was used in some sea mines and torpedoes.

Reference:

Allied & Enemy Explosives, Aberdeen Proving Ground, Md, (1946), pp 110-11.

Nitroparaffine. German research on the preparation and properties of nitroparaffins is described in CIOS Rept 33-41 (1945). See also general section under Paraffins.

Nitropenta (Np). See Pentrit (PETN).

Nitropentaerythrit. See Pentrit.

Nitrostärke (Nitrostarch). See general section under Starch.

Nitrotoluol. See general section under Toluene.

Nitrous Oxide, N_2O. Same as GM-1. See also general section.

Nitroxylol. See general section under Xylene.

Nitrozellulose. Same as Nitrocellulose.

Nitrozucker (Nitrosugar). See general section under Sugar.

Nisol, See under Spies Section.

Nobelit (Nobelite). A type of permissible gelatin-dynamites used before and after WW I. Two examples are given in Table 29

Table 29

Composition (%) and some properties	Nobelite	Nobelite 19
NG (gelatinized with NC)	28.7	26.0
DNT	-	2.0
Dextrin	2.5	-
Wood meal	1.0	1.0
Potato flour	10.0	-
Vegetable oil	0.5	-
Am nitrate	39.7	34.0
Am chloride	17.6	32.0
Saturated soln of Ca nitrate	-	5.0
Oxygen Balance, %	-	5.0
Density	-	1.75
Velocity of Detonation, m/sec	-	3750
Trauzl Test, cc	270	220

(See also Wetter-Nobelit)

References:

1) P.Naoúm, Schiess- und Sprengstoffe (1927), p 150
2) P.Naoúm, Nitroglycerin (1928), p 407.

Nobels' Sprengöl oder Sprengöl. Same as Nitroglycerin.

Nobels' Wetterdynamit I. One of the older permissible dynamites: NG 30, Na nitrate 31, flour 30, wood meal 6, napthalene 2 and alum 1%. Veloc of detonation 3860 to 3930 m/sec at d 1.16 [Marshall 2 (1917), p 492].

Non-Destructive Testing of Materials. Some of the German methods of testing are described in BIOS Final Rept 609 (1946). See also general section.

Normales Gasvolumen (Normal Gas Volume). Volume of gas at normal temperature (0° or 20° C) and normal pressure (760 mm) or Gas volume at NTP. Calculation of the volume of gas developed on explosion is described in the general section.

[See also A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 13-14].

NSP. See under Ignition.

NzMonNP. See under Ignition.

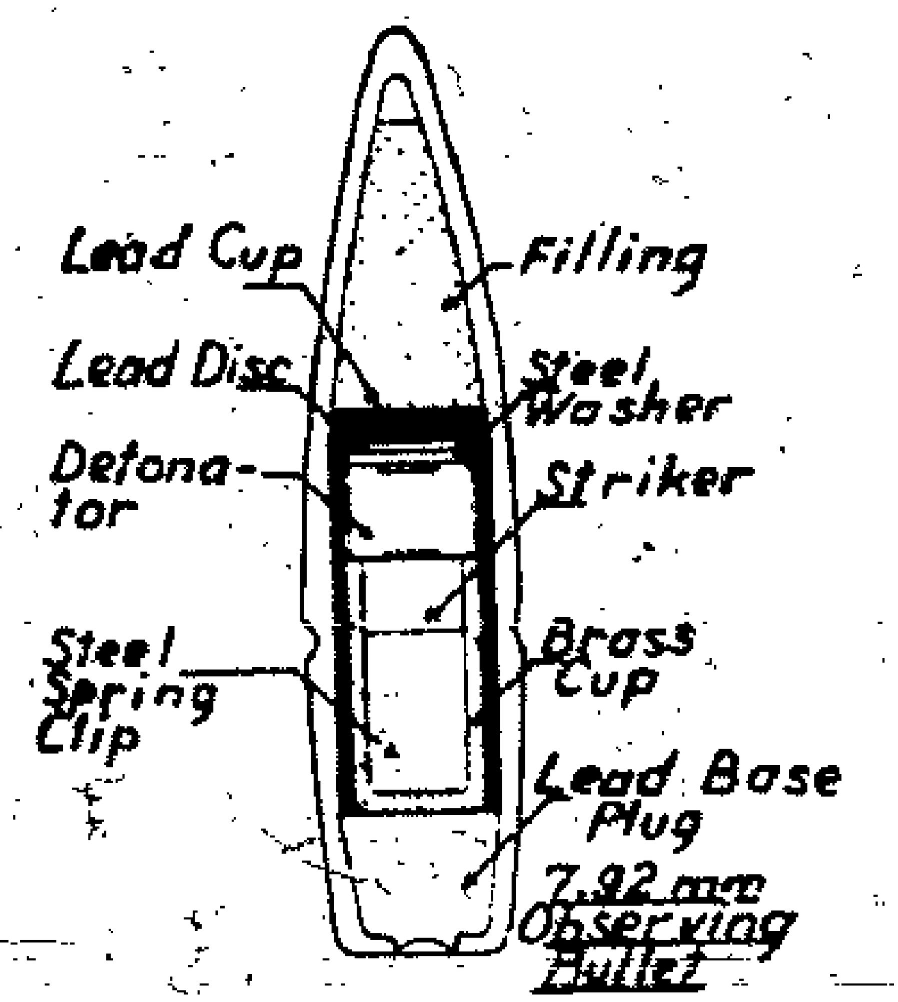
Oberflächenbehandlung (Surface Treatment). See general section under Surface Treatment of Explosives, Propellants, Pyrotechnic Compositions, etc.

Oberon Gerät. A device designed in 1944 for controlling the bursting point of the air-to-air incendiary rocket, R 100 BS. It was claimed that the Oberon device improved the chance of a strike from a negligible value to a probability of about 0.4.

Reference: TM 9-1985-2 (1953), p 255.

Observing Bullet, caliber 7.92 mm, developed by the Deutsche Waffen- und Munitionsfabriken A-G, Lubeck, exploded with a flash on hitting the target. The bullet consisted of a steel casing containing a charge of white phosphorus, a detonator and a striker with a steel spring. The base of the casing was closed with a lead plug.

Reference: H.Peploe et al, CIOS Rept 33-20 (1946), pp 26-7 (See drawing on next page).



Octogen. German name for Cyclotetramethylene Tetranitramine, $(H_2C:N{\cdot}NO_2)_4$, called by the British HMX (His Majesty's Explosive or High Melting Explosive). This compound was present as an impurity in Hexogen (RDX or Cyclonite) when prepared either by the E-Verfahren or by the KA-Verfahren. It was found by the Germans that Octogen is more sensitive to friction than Hexogen, but is more stable to heat.
(See HMX in the general section).

Ofenrohr (Stove Pipe). See under 88 mm Weapons.

Offensivität eines Treibmittels (Offensiveness of a Propellant). In order to be sure that a weapon (such as a rifle or gun) will not burst on firing, it is necessary to know the pressure developed on combustion of the propellant and the rate of pressure increase (Geschwindigkeit der Drucksteigerung). If any of these values are greater than calculated for a given weapon, the propellant is not suitable. Also, it must be certain that the combustion of a propellant will not develop into a detonation. The faster the rate of increase of pressure of a propellant the greater is the Offensivität.

This property of a propellant may be judged from the following test:

Usual fixed charges of various propellants to be tested are fired in a weapon provided with a device for determining the gas pressure. The tests are repeated with charges increased 25% and then with charges increased 50%. Table 30 gives results of tests conducted by Brunswig. (See below).

Reference:
H. Brunswig, Das rauchlose Pulver, W. de Gruyter, Braunschweig (1926), pp 220-221.

Optolene. A liquid rocket fuel consisting of about 50% Visol, 10-20% aniline and the rest being Optol (a coal tar product containing phenol), benzene and xylene. Density 0.9. It was used in the Wasserfall missile in conjunction with concd nitric acid (contg about 10% sulfuric acid), which served as an oxygen carrier. The ratio was 0.24 parts of Optolene per 1 part of acid. The theoretical specific impulse for this mixture was 214 lb/lb/sec, but they actually obtained only 183. This value was nearly equal to that obtained when using Visol/nitric acid.
Reference: Gollin, CIOS Rept 28-56 (1945), p 19.

Pak oder PAK. Abbreviation of Panzerabwehrkanone, which means Antitank Cannon, or more literally Anti-Armor Defence Cannon.

Palatinol. Trade name for aliphatic ortho-phthalic acid esters of the general formula $C_6H_4(COO.C_nH_{2n+1})_2$, proposed in 1927 by Noll as plasticizers for NC. Palatinols were manufactured during WW II by the I G Farbenindustrie and used in some propellants and explosives.

Following are examples of Palatinols:
Palatinol A. Diethylester of o-phthalic acid
Palatinol C(Elaol) Dibutylester of o-phthalic acid, d 1.0543 and b p 320°C
Palatinol HC. Di-iso-butylester of o-phthalic acid; d 1.0490 and b p 305 to 315°C
Palatinol M. Dimethylester of o-phthalic acid.

Palatinols are practically non-volatile (an advantage over camphor) and do not become rancid in storage (an advantage over castor oil).

References:
1) W. Krannich, Kunstoffe, Lehmann, Berlin (1943), p 40
2) Kast-Metz, Chemische Untersuchung der Spreng- und Zündstoffe, Vieweg, Braunschweig (1944), p 161.

Pentopollit. A dynamite manufactured more than 50 years ago at Opladen, near Köln: NG mixed with napthalene 70, kieselguhr 20, Ba sulfate 7 and chalk 3%. [Daniel, Dictionnaire, Paris (1902), p 599].

Table 30
(Offensivität)

Charges	Sample 1 Gas pressure (atm)	Sample 1 Pressure increase Atm	Sample 1 Pressure increase %	Sample 2 Gas Pressure (atm)	Sample 2 Pressure increase Atm	Sample 2 Pressure increase %	Sample 3 Gas Pressure (atm)	Sample 3 Pressure increase Atm	Sample 3 Pressure increase %
Usual fixed	620	-	-	540	-	-	400	-	-
Increased 25%	1000	380	61	800	260	48	890	490	122
Increased 50%	1160	160	16	1040	240	30	1300	410	46

Note: Of the three samples the last has the highest Offensivität because the percentage increase in pressure is the greatest.

PANZER (Armor or Armed Vehicle) (In collaboration with Col G.B. Jarrett and Mr K.F. Kempf of Museum, Aberdeen Proving Ground, Md).

Under the term Panzer, the Germans included the following armed vehicles:

a) **Aufklärungspanzer** (AufklPz). Light armored reconnaissance vehicle
b) **Flakpanzer** (FlakPz). Special vehicle with full armor cover; used as AA weapon
c) **Fliegerleitpanzer.** Armored observation car used with front line support aircraft
d) **Funklenkpanzer.** Radio guided, light armored vehicle for special uses
e) **Funkpanzer.** Armored vehicle for troop radio communication
f) **Gepanzerte Munitionstransport Kampfwagen.** Armored vehicle for transporting ammunition. It belonged to the class of Schützenpanzerwagen
g) **Jagdpanzer** (JgdPz), called also **Panzerjäger** (PzJäg). Tank destroyer, tank hunter or pursuit tank. It was a highly mobile, lightly armored and heavily armed combat automotive vehicle constructed of a half track or tank chassis and designed to catch up with and destroy enemy tanks. Like a tank it was able to leave roadways and maneuver over rough terrain
h) **Landepanzer.** Armored amphibious troop carrier.
i) **Luftlandepanzer.** Light armored vehicle used with Airborne
j) **Munitionstransport Kampfwagen.** See Gepanzerte Munitionstransport Kampfwagen
k) **Panzerbefehlswagen** (PzBefWg) Commander's tank. It carried a superstructure, a two-way radio and a minimum of armor and arms
l) **Panzerbeobachtungswagen** (PzBeoWg). Armored car used for artillery spotting
m) **Panzerjäger.** See Jagdpanzer
n) **Panzerkampfwagen** (PzKpfw or PzKpfWg), called also **Kampfwagen** (KpfWg), **Panzerwagen** (PzWg), or simply Panzer, was a heavily armored automotive combat vehicle mounted on a tractor (such as a caterpillar type) and capable of traversing very rough terrain; used in organized front line units for a spearhead.

Note: The first tank was built during WW I by the British and used in September 1916 on the Somme. In order to keep secret the construction of the new weapon, it was listed in shop orders as "A Water Carrier from Mesopotamia" and this name was later shortened to "Tank" (Ref 8)

o) **Panzerkampfwagen Flammenwerfer.** Armored vehicle equipped with a flame thrower
p) **Panzermunitionstransport Kampfwagen.** See Gepanzerte Munitionstransport Kampfwagen
r) **Panzerspähwagen** (PzSpW or PSW). Rapid, lightly armored vehicle for reconnaissance
s) **Panzerwagen.** See Panzerkampfwagen
t) **Panzerwerfer.** Armored rocket projector
u) **Schützenpanzerwagen** (SPW) Multipurpose armored car used with Armored Infantry, e g to transport personnel or ammunition
v) **Selbstfahrlafette** (Sfl or Sf). Self-propelled artillery consisting of gun mounts (gun carriages) which had their own motor power to carry them into combat. Each mount could have protective armor and heavy caterpillar treads to enable it to leave roadways and maneuver over rough terrain. It differed from Towed Guns
w) **Sonderkraftfahrzeug** (SdKfz). Any specialized vehicle, such as a tank, tank destroyer or self-propelled mount, might be designated as SdKfz
x) **Sturmpanzer** (StuPz), called also **Sturmgeschütz** (StuGesch). Front line support armored vehicles supplying overhead fire power against infantry.

Following is a brief description of tank development in Germany before and during WW II:

Due to the restrictions imposed by the Treaty of Versailles (1919), the Germans did not have the right to build tanks. Nevertheless they by-passed the restrictions and started to build tanks as early as 1926 when Rheinmetall Co came out with a 21-ton tank armed with a 75 mm gun. In 1927-1928 the so-called Landwirtschaftlicher Schlepper, abbreviated as LAS (Agricultural Tractor) was constructed, which by a clever arrangement, could be easily converted into a tank and this was later done. The resulting tank was designated as PzKpfw I or SdKfz 101. Its first variation (Model a), which appeared before the Spanish Civil War (1934), weighed 5.7 tons and had a max speed of 25 mph, while its second variation (Model b) weighed 6 tons and had a max speed of 32 mph. Both models were armed with 7.92 mm machine guns, MG 13 (Dreyse). The chassis of Model b, was also used for the commander's tank (PzBefWg I), for the tank destroyer PzJag I (which was armed with a 4.7 cm Pak (t)) and for a self-propelled mount carrying a 15 cm sIG 33 (150 mm medium infantry gun)

Several other tanks were constructed in the period before the Nazis repudiated the treaty of Versailles, but the real work started after 1933 when the following plants went into tank development and production: a) Friedrich Krupp, Essen; b) MAN, Nürnberg; c) Daimler-Benz, Berlin-Marienfelde; d) Henschel, Kassel and e) Rheinmetall, Düsseldorf.

The first design project was a 10-ton tank begun in 1934 out of which the PzKpfw II or SdKpfz 121 was eventually developed. The handling of this project set the pattern for nearly all the tanks developed up to about 1941, such as 30-t, 35-t and even 60-t tanks (designed by Henschel in 1937-1939), but they were never mass-produced.

PzKpfw II

The original tank, PzKpfw II (SdKfz 121) weighed about 11.5 tons and carried one 20 mm gun (either 2 cm KwK 30 or 2 cm Pak 38) and one 7.92 mm MG. Its max speed was 30 mph. The tank was made in several modifications (a, b, c, f, g & j). Its chassis was also used for a tank destroyer, a self-propelled mount, etc such as:

a) Tank destroyer, nicknamed Marder II (Marten II) and designated 7.5 cm Pak auf Sf II (SdKfz 131) which carried one 75 cm A/T gun pattern 40/2, 48 calibers long. Wt 11.6 tons and max speed 25 mph. Its modification carrying one Russian 76.2 mm A/T gun was designated 7.62 cm Pak (r) auf Sf II Ausf B (SdKfz 132).

Note: Marder 38 is described at the end of this section under Czech tanks.

b) Self-propelled mount nicknamed Wespe (Wasp) and designated 10.5 cm lFH auf Sf II (SdKfz 124) carried one 105 mm light howitzer known as 10.5 cm lFH 18 M; total wt 12.5 tons, max speed 25 mph
c) Self-propelled mount, designated 15 cm sIG 33 auf Sf II, carried one 150 mm medium infantry gun (howitzer), pattern 33; total wt 12 tons, max speed 25 mph
d) Flame thrower tank designated as PzKpfw II (FlW) or Panzerkampfwagen II (Flammenwerfer), carried two flame throwers and one MG 34, wt 12.6 tons and max speed 34 mph
e) Reconnaissance tank, nicknamed Luchs (Lynx) and designated as AufklPzII, lPzSpWgII (SdKfz 123) carried one 20 mm gun (2 cm KwK 38) and one MG. Wt 13 tons and max speed 40 mph.

PzKpfw III

Although the design of PzKpfw III started several years before WW II, the tank did not reach the front until 1941, later than the PzKpfw IV. The tank III was known in several modifications and some of them were equipped with torsion bar suspension designed by Dr Porsche.

In general PzKpfw III was considered one of the most original and successful German tanks. About 6700 of them were produced between 1941 and 1943, most of them at the Daimler-Benz factory.

Following are the principal tank III versions as well as a flame thrower and self-propelled mounts utilizing PzKpfw III chassis:

a) PzKpfw III (Models A, B, C, D & E) (SdKfz 141) were tanks weighing 18 to 20 tons armed with one 50 mm short barrel gun (5 cm KwK) and two MGs 34. Max speed 28 mph
b) PzKpw III (Models F, G & H) were tanks weighing about 25 tons and armed with one 50 mm short barrel gun (5 cm KwK) and two MGs 34. Max speed 28 mph.

Note: The above gun fired a 4½ lb shell at a muz vel of 2250 f/s.

c) PzKpfw III [Models J, J(Tp) & K] were tanks weighing about 24.5 tons and armed with one 50 mm long barrel gun (5 cm KwK 39) and two MGs 34. Max speed 28 mph.

Note: As the short gun of previous models proved to be inefficient against American medium tanks M3 (General Grant), it was replaced by a long gun (60 calibers long) which had a much higher muzz vel. Model J marked Tp (Tropen) was insulated against African desert heat.

d) PzKpfw III (Models L, M, N & O) were tanks weighing about 24 tons and armed with two MGs 34 and one 75 mm gun (7.5 cm KwK) or one 37 mm long barrel gun (3.7 cm KwK 39). Max speed 28 mph
e) Commanders tank, PzBefWg III (SdKfz 143) weighed 24.5 tons and carried a dummy 37 mm or 50 mm gun and two MGs which might also have been dummies. Max speed 25 mph.

f) Flamethrower tank, PzKpfw III (F) or Panzerflammwagen III, weighed 25.7 tons and carried one flamethrower and two MGs 34. Max speed 22 mph

g) Antiaircraft tank, nicknamed Kugelblitz and designated Flakpanzer III, carried one 30 mm twin AA gun called 3 cm Flakzwilling Mk 103

h) Self-propelled mounts designated as Sturmgeschütz III (StuG III) were in three versions:

1) SdKfz 142 carried one 75 mm short assault gun (7.5 cm KwK L/24). Wt 26 tons and max speed 28 mph

2) SdKfz 142/1 carried one 75 mm long assault gun (7.5 cm KwK L/43 or 7.5 cm KwK L/48). Wt 26 tons and max speed 25 mph

3) SdKfz 142/2 carried one 105 mm assault howitzer (10.5 cm StuH 42 L/28). Wt 27 tons and max speed 25 mph.

PzKpfw IV

The work on the development of PzKpfw IV began at the Krupp plant as early as the summer of 1936 and the tank was actually used in the Polish (1939) and French (1940) campaigns.

Following are the versions of tank IV as well as the self-propelled mounts utilizing chassis of PzKpfw IV, PzKpfw III/IV, PzJäg IV or PzJäg III/IV:

a) PzKpfw IV (Models A, B, C, D & E) (SdKfz 161) were tanks weighing 22.4 to 24.6 tons and armed with one 75 mm gun, 24 calibers long and two MGs 34. Max speed 28 mph

b) PzKpfw IV (Models F & G) (SdKfz 161/1) and (Models F, J & K) S(dKfz 161/2) were tanks weighing about 26 tons and armed as follows: one 7.5 cm KwK L/24 or one 7.5 cm KwK 40 L/48 for models F and G, and one 7.5 cm KwK L/48 for models F, J & K

Notes: The 75 mm gun, 24 calibers long, fired a 15.5 lb shell with a velocity of 1650 f/s, while the 75 mm gun, 48 calibers long, fired the same shell with a velocity of 2600 f/s

c) Tank destroyer designated as Jagdpanzer IV (JgdPz IV), Panzerjäger IV (PzJäg IV) or SdKfz 162, weighed about 26.5 tons and carried either a 75 mm assault gun, 48 calibers long (7.5 cm StuK 42, L/48) or a 75 mm assault gun, 70 calibers long (7.5 cm StuK 42, L/70). The ensemble weighed about 26.5 tons and had a max speed of 25 mph

Note: This weapon was listed by G.B. Jarrett as a self-propelled mount.

e) 8.8 cm Pak 43/1 auf PzKpfw IV (SdKfz 164), nicknamed Hornisse (Hornet) consisted of an 88 mm A/T gun on a tank IV chassis. Max vel of the gun was 3281 f/s. The weapon served successfully at the Russian front and was later redesignated as Nashorn (see below)

f) 8.8 cm Pak 43/1 auf PzJäg III/IV, designated also 8.8 cm Pak auf Sf IV and nicknamed Nashorn (Rhinoceros) consisted of an 88 mm A/T gun, 71 calibers long on a tank IV chassis. The ensemble weighed 26 tons and its max speed was 22 mph

Notes: The gun of the Nashorn fired a 22 lb shell with a max vel of 3280 f/s. The gun in the Tiger II had the same muzzle velocity and used the same ammunition

Both the Hornisse and the Nashorn were listed by G.B. Jarrett as self-propelled mounts

g) Self-propelled mounts (Selbstfahrlafetten IV, abbreviated Sf), called also assault guns (Sturmgeschütze) existed in the following models:

1) 2 cm Flakvierling auf Sf IV, nicknamed Wirbelwind (Whirlwind) was a 20 mm four-barreled AA gun on a tank IV chassis. It was used since 1944

2) 3.7 cm Flak auf Sf IV, nicknamed Ostwind (East Wind) was a 37 mm AA gun on a tank IV chassis. It was used since 1944

3) 10.5 cm StuH 42 L/12 auf PzKpfw IV, designated also as 10.5 cm lFH 42 auf Sf IV, consisted of a 105 mm light howitzer, 12 calibers long on a modified tank IV chassis. It weighed 19.2 tons and had a max speed of 25 mph

4) 15 cm StuH 43 (or 15 cm sIG 33) auf PzKpfw IV, designated as SdKfz 163, consisted of a 150 mm medium heavy infantry gun 33 on a tank IV chassis. It weighed 29 tons and had a max speed of 25 mph. It was also called Sturmpanzer 43 and nicknamed Brummbär (Grizzly Bear)

5) 15cm sFH 18/1 auf PzKpfw III/IV, also designated 15 cm sFH auf Sf IV (SdKfz 166), consisted of a 150 mm medium heavy howitzer on a tank III/IV chassis. It was nicknamed Hummel (Bumble-Bee). Wt 28 tons and max speed 25 mph

Some modified tank IV chassis were used as ammunition carriers (Munitionsträger) and one of the units carried a crane and shells for heavy mortars Karl and Thor. (See Thor and Karl Mortars

Most of the above tanks were very successful in the invasion of Poland (1939), Belgium, Holland and France (1940) but proved to be inadequate during the campaign in Russia (1941) when the heavier T-34 tank was encountered. As result of this failure, a complete revision of the German tank program was ordered (in 1941) by the High Command. It was decided to develop much heavier models, e g, 50 tons. This did not mean, however, that the production of all previous models stopped. Over 10,000 PzKpfw III and PzKpfw IV were produced in 1943-1944 and only about 100 PzKpfw II tanks

The first tank constructed under the new program was the Tiger I (P) or PzKpfw VI (P) designed by Porsche. As it did not prove to be very successful as a tank, its chassis was modified and used for the tank destroyers Ferdinand and Elefant (Elephant) (See below)

Slightly later (in 1942) appeared the tank developed by Henschel Co and designated as Tiger I (H). This model was adopted for service and its production started in the fall of 1942

At about the same period another heavy tank known as the Panther was developed and went into production early in 1943. This tank was intended to replace Panzer III and Panzer IV because Tiger I, called since 1943 Tiger E or PzKpfw VI (E), gave rather inadequate service at the Russian front. Redesign of the tank was ordered by the High Command in order to meet all the requirements of the front. The newly designed tank was called Tiger II or King Tiger (See below).

Following is the list of Panthers and Tigers:

Panther (PzKpfw V)

a) Basic model of the PzKpfw V (SdKfz 171) Panther weighed 47 tons and carried one 75 mm gun, pattern 42 (7.5 cm KwK 42) and two MGs 34. It carried a 4" gun in the top front, a 3" gun in the bottom front and 2" guns at the sides. Max speed 30 mph

Notes: The tank enjoyed immunity from most Allied projectiles as far as its front was concerned, but the sides could be penetrated. Its 75 mm gun was capable of firing a 15 lb shell with a muz vel of 3066 f/s. The most striking feature of this tank was the long frontal plate similar to the one found in the Russian T-34 tank. Many of the Panthers were covered with a cement-like paste, which had a very rough surface. The paste was intended to prevent magnetic mines sticking to the tanks, (some mines were drawn to the tanks by means of magnets)

b) Tank destroyer Jagd Panzer V (JgdPz V), PzJäg V, SdKfz 173 or 8.8 cm Pak 43/3 auf PzKpfw V, weighed 51 tons and had a max speed of 30 mph. Its 88 mm A/T gun, pattern 43 was capable of firing a 22 lb shell with a velocity of 3280 f/s.

Tiger (PzKpfw VI)

a) Original model, PzKpfw VI (P) or Tiger I (P), was an 80 ton tank developed by Porsche, the designer of the Volkswagen and Porsche automobiles. The tank was equipped with an air-cooled engine and an electric drive. About 100 tanks were built and shipped to the Russian front for testing under battle conditions. Because of some mechanical failures, the tank was not accepted for service and preference was given to the tank Tiger I (H) developed by Henschel (See below). Meanwhile Porsche modified the chassis of his tank and converted it to a self-propelled motor carriage known as "Ferdinand", PzJäg VI Ferdinand, SdKfz 184, Jagd Pz VI (P) or Tiger Porsche. It was equipped with one MG and one long-barreled 88 mm gun (8.8 cm KwK 36), very effective against armor. This tank destroyer was superseded by Elefant (Elephant), designated as SdKfz 184a, which carried one MG and one 88 mm A/T gun, 71 calibers long (8.8 cm Pak 43, L/71). The ensemble weighed about 75 tons and had a max speed of 22 mph.

Note: F. von Senger und Etterlin (Ref 9, p 192) called the above tank destroyer, the JgdPz VI Ausf Porsche, and gave

its properties as follows: wt 68.8 metric tons (about 75.6 short tons), max speed 35 km (22 mph) and it carried one 128 mm A/T gun, 55 calibers long (12.8 cm Pak, L/55) and one MG.

b) Tiger I tank, designed by Henschel Co and adopted by the High Command for service, was called PzKpfw VI (H) or SdKfz 181. The designation was changed in 1943 to PzKpfw VI (E) or Tiger E and about 1000 of these tanks were produced that year. The wt of the tank was about 60 tons, max speed 25 mph and it carried one 88 mm gun, 56 calibers long (8.8 cm KwK, L/56) and two MGs 34

c) Tiger II or Tiger B tank, designated PzKpfw VI (B) or SdKfz 182, called also Königstiger (King Tiger or Royal Tiger), weighed 75 tons, had a max speed of 24 mph and was equipped with two MGs 34 and one 88 mm gun 71 calibers long (8.8 cm KwK L/71). It incorporated the sloping frontal plate armor (6" thick), which had proven very successful in the Panther design. Its side armor was slightly thicker than 3". The tank was designed for submersion up to 13 ft and all the joints were made waterproof by using rubber seals. It resembled the Panther in appearance but was larger and more effective in performance. Although its design was finished only in 1943, more than 500 Tigers II were produced by Henschel Co before the war was over

d) Tank destroyer, Jagdpanzer VI (JgdPz VI) or Panzerjäger VI B (PzJäg VI B) was a 77 ton armored vehicle built by the Nibelungenwerke. It carried one MG and one 128 mm A/T gun, 55 calibers long (12.8 cm Pak, L 55). Max speed 22 mph

e) Jagd Tiger or Tiger Jäger was a 77 ton tank destroyer equipped with a 128 mm gun, 66 calibers long (12.8 cm Pak 44 or 12.8 cm PJK 44). Max speed 25 mph

f) Sturmtiger (Sturmpanzer VI mit 38 cm Mörser), called also Sturmmörser, was a self-propelled mount consisting of a 380 mm Rocket Projector (38 cm Raketenwerfer 61) mounted on a Tiger E chassis. It weighed 68 tons and had a max vel of 25 mph.

Czech Tanks

During World War II the Germans also used some Czech tanks, such as the T-38, manufactured by Skodawerke, Pilsen. The original model, built before WW II, was designed by the Germans as PzKpfw 38(t). It weighed 11.2 tons and carried one 37 mm gun 37 (Czech) [3.7 cm KwK 37(t)] and one MG 37 (Czech). Its maximum speed was 16 mph.

Because the above 37 mm gun had insufficient armor penetration, it was replaced in 1942 by a more powerful gun, the 7.5 cm KwK 40, L/48. It had no muzzle brake. At the same time the speed of the tank was increased by installing a more powerful engine. The resulting ensemble was a tank destroyer designated as Jagdpanzer 38(t) nicknamed Hetzer (Baiter). It weighed 17.5 tons and had a max speed of 23.5 mph. It also carried one MG 34.

Note: "Hetzer" resembled in appearance PzJag 13(Schweiz) except that the gun on this Swiss tank had a muzzle brake.

Another version of T-38, designated JagdPz 38 Flam, carried a flame thrower in lieu of a gun. Other T-38 versions served as self-propelled mounts: the first SP mount, designated 15 cm sIG 33/1 auf PzKpfw 38(t), carried a 150 mm medium heavy infantry gun (howitzer) 33/1, the second, designated 2 cm Flak auf PzKpfw 38(t), carried a 20 mm AA gun, and the third, nicknamed Marder 38 (Marten 38), existed in two modifications: one, designated SdKfz 138, carried a 15 cm Pak 40/3 L 46, while the other designated SdKfz 139, carried a 7.62 cm Pak 36 (russ).

Note: There was also a tank destroyer Marder II, which is briefly described above under PzKpfw II.

Some of the French tanks, such as the Lorraine, Renault, Hotchkiss, and Char B served as gun carriers. One of the foreign tanks used by the Germans was the Swedish Landswerke (L-60), designed by Weiss. The tank was built during WW II at Budapest (Ref 7, pp 110-115).

There were also many wheeled armored cars built in Germany. Some information about them is given by Jarrett (Ref 7, p 116).

Several Experimental Tanks other than those previously mentioned and also tank destroyers were designed by the Germans, but none of them was put into production.

Following is a partial list of these vehicles:

a) Leopard (Leopard). A 28-ton tank developed in 1942 at Daimler-Benz plant (Ref 5, p 10)

b) Maus (Mouse) A 100-ton tank developed in 1942 by Porsche at Nibelungen Werke. It was equipped with a gas-electric drive, same as in Tiger I (P) and carried one 150 mm gun, several MGs and a flame thrower. (Ref 5, pp 11-12)

c) Krupp-Maus (Krupp Mouse). Heavy tanks: 110- 130- 150- and 170 ton, developed in 1942 by Krupp Co. (Ref 4, p 6)

d) Series E tanks of which E-100 was a super-heavy tank of 130-140 tons. The E-series was designed in 1943-1944 by the engineering staff of Adlerwerke, Frankfort a/M under direction of HWA (Heereswaffenamt) (Refs 3 and 5)

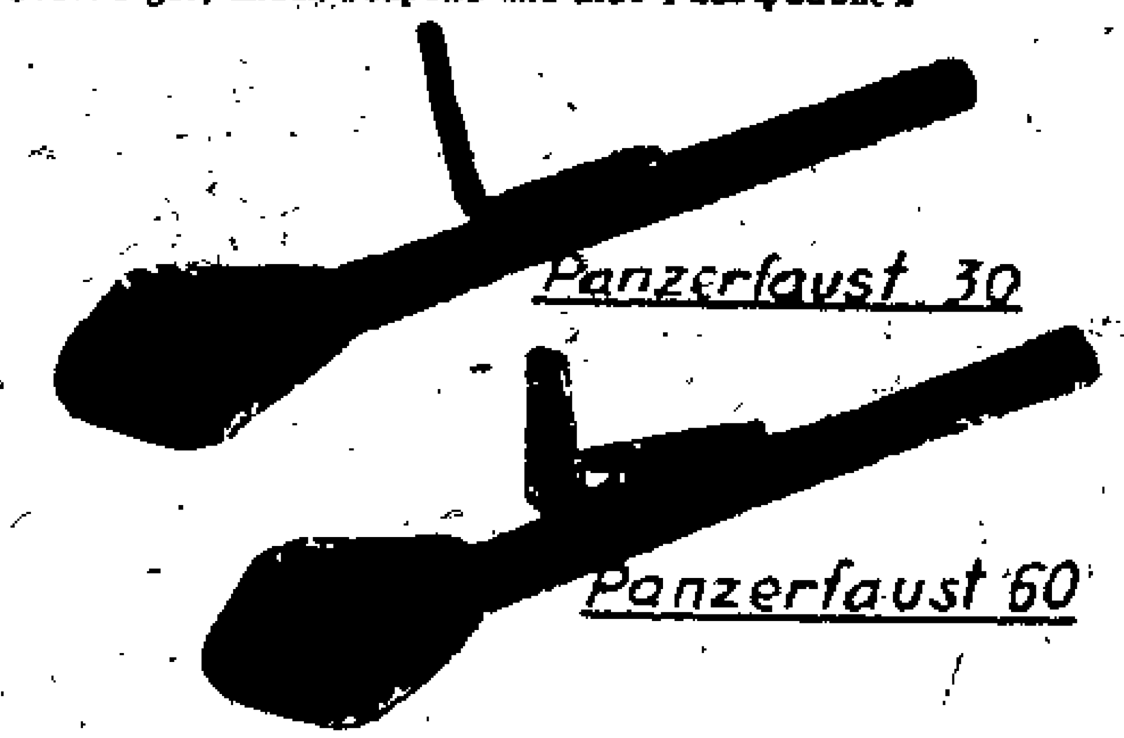
e) Bär (Bear) was a 100-ton tank which carried a 305 mm breech-loading mortar (not rocket type) (Ref 4, p 6)

f) 1500-ton tank mounting an 800 mm gun as main armament and two 150 mm guns in rear quarter turrets. The frontal armor was 250 mm thick and placed at 45 degrees (Ref 4, p 6).

References:

1) Anon, Field Artillery Journal, 34, 368-9 (1944)
2) G. B. Jarrett, Ibid. 35, 434 (1945)
3) CIOS Rept 28-3 (1946) Development of "E" Tank
4) CIOS Rept 29-22 (1946) History of German Tank Development
5) CIOS Rept 32-33 (1946) Tank Development at the Daimler-Benz Factory
6) CIOS Rept 32-35 (1946) Development of New Series of German Tanks up to End of March 1945
7) G.B. Jarrett, "Achtung Panzer". The Story of German Tanks in World War II, Great Oaks, RD 1, Aberdeen Md (1948)
8) Merriam-Webster's New International Dictionary, Merriam Co, Springfield Mass (1951), p 2577
9) Dr F. v. Senger u Etterlin, Taschenbuch der Panzer 1943-1954, Lehmanns Verlag, München (1954).

Panzerfaust (Armored Fist). A hollow charge antitank rocket grenade fired from a tubular discharger. Its smaller model Panzerfaust 30 klein, was formerly called Faustpatrone 1 and its larger model Panzerfaust 30 was called Faustpatrone 2. The latest models were Panzerfaust 60 and Panzerfaust 100 (See also 44.5 mm Recoilless Grenade Discharger, under Weapons and also Faustpatrone).



Panzergranate Pzgr (Armor-piercing Projectile; Antitank Shell). Many types of such projectiles are listed under Granate and described in TM 9-1985-3 (1953).

Besides the conventional types of AP projectiles, and projectiles with hollow (shaped) charges, the Germans used some Sabot projectiles such as Type G Sabot Projectile (p 367) and the 75/88 mm-Brand-Sabot Projectile, developed by the French establishment of Edgar Brand. More effective were the Arrowhead Type Projectiles with a Tungsten Carbide Core such as: 2.8-2.0 cm Pzgr used in Tapered Bore Gun PzB 41 (p 377), 3.7 cm PzgrPatr 40 used in Cz 3.7 cm Pak (p 373), 4.2-2.8 cm PzgrPatr used in Tapered Bore Gun LPak 41 (p 375), 4.7 cm PzgrPatr 40 used in Czech guns 4.7 cm Pak(t) and 4.7 cm K 36(t) (p 375), 5 cm PzgrPatr 40 used in Tank guns 5 cm KwK & 5 cm KwK 39 and in A/T Gun 5 cm Pak 38 (p 376), 7.5 cm PzgrPatr 41 used in A/T Gun, 7.5 cm Pak 41 (p 378).

A unique, light and effective AP projectile was designed for use in the Russian 76.2 mm A/T guns. At first the Germans attempted to adopt the arrowhead type projectile Pzgr 40 but found it unsuitable. In its place they developed a projectile of normal shell design, but employed a plastic interior sleeve to give body to the shell and still keep it relatively light. This shell, described by E. Englesburg in the Ordnance Sergeant, May 1944, p 312, consisted of the following components: a) a ballistic cap of an aluminum alloy, screwed onto the shell, b) an armor-piercing core, consisting of tungsten carbide plated with nickel, which was pressed into c) a steel core holder, d) a sleeve of molded plastic surrounding the core and its holder and filling the space between the body and these components, forming an ogival head with the ballistic cap. The plastic had a fairly high shock resistance.

Still more effective were Arrow of Needle Type Projectiles designed by O. Gessner.

The projectiles constructed at the Röchling Plant at Saarbrücken were very effective for penetrating concrete. (See also under Arrow Projectiles, Arrowhead Projectiles, Gramm, Gessner Projectiles, Röchling Projectiles and ~~Saber Projectiles~~).

Panzerhandmine. See under Hafthohlladung.

Panzerschnellmine. See under Landminen and also p 262 of TM 9-1985-2 (1953).

Panzerschreck, Panzerfaust, Panzerwurfkanone und Püppchen were the shaped charge weapons developed before and during WW II in Germany.

The Panzerschreck was the shaped charge rocket, similar to the American Bazooka, but was heavier and had a shorter range than the latter. It was superseded by the Panzerfaust, which was a better weapon with a range of 150 meters. Another weapon, called the Püppchen, was essentially the 8.8 cm Panzerschreck mounted on a light carriage. The Panzerwurfkanone was a long-range weapon for shooting a shaped charge, developed by the Rheinmetall Co. It was a smooth-bore 8.0 cm mortar. (See also under 80 mm and 86 mm Weapons).

References:

1) L.E.Simon, German Research in WW II, Wiley, N Y (1947), pp 187-8
2) A.Stettbacher, Spreng- und Schiessstoffe, Rascher, Zürich (1948), p 134.

Panzerwerfer 42. See under Rocket Launchers.

Panzerwurfkanone. See under Panzerschreck.

Panzerwurfmine 1(L). A shaped charge hand grenade, introduced by the Luftwaffe for use in close combat against armored vehicles of all types. Diameter of body 11", overall length 21", weight 2.1 lb. It was provided with four collapsible cloth vanes which were folded against the handle. When the grenade was thrown, the vanes sprang open and stabilized projectile in flight.

Reference:

1) A.J.Dere, Ordnance Sergeant, Oct 1945, p 8
2) Anon, Intelligence Bulletin 3, No 7 (1945).

PANZERWURFMINE 1(L)

Pappmine. See under Landminen and also on p 261 of TM 9-1985-2 (1953).

Parachute Flare. See under Flare.

Perammon. Mixture of Am perchlorate 90 and paraffin 10% used for military purposes. [A.Stettbacher, Spreng- und Schiessstoffe, Zürich (1948), p 91].

Pathfinder Bombing. A night bombing tactic developed during WW II in Great Britain and used against the Germans. The tactic consisted of dropping bombs on a target previously illuminated by flares dropped from the leading planes.

This method permitted more accurate bombing of the target.

Reference: A.B.Schilling of Picatinny Arsenal; private communication (1955).

(See also Pyrotechnic Antipathfinder Devices).

Patrone. See Cartridge.

PC 1400 FX was a radio controlled glider bomb, released from aircraft and designed for attack against capital ships or smaller objects. [TM 9-1985-2 (1953), pp 195-6].

Peenemünde. A rocket research center, including an air tunnel, constructed in 1936-1937 in an isolated spot on the German Baltic coast. The first rocket developed at Peenemünde was the A-3, the predecessor of the A-4 Rocket, commonly known V-2.

A fairly detailed description of Peenemünde Rocket Center and its activities is given in Ref 4.

Peenemünde is now in the Eastern Zone of Germany.

References:

1) A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 103-110
2) L.E.Simon, German Research in WW II, Wiley, N Y (1947) pp 33 & 130
3) J.G.Tschinkel, Chem Eng News 32, 2582 (1954)
4) W.Dornberger, V-2, Viking, N Y (1954).

Pento. Same as Pentrit (PETN).

Pentastit. See Swiss section.

Pentol oder Pentritol corresponds to the American Pentolite, described in the general section.
(See also Fillers Nos 16, 17, 28, 42 and under Pentrit).

Pentrinit. See under Swiss Explosives.

Pentrit oder Nitropenta (NP). See general section under Pentaerythritoltetranitrate (PETN). It was manufactured in Germany by batch, continuous or semi-continuous methods.

A) The batch method was essentially the same as that used in the U S A

B) The continuous method, as conducted at Troisdorf Fabrik, D A -G consisted essentially of the following operations:

a) Nitric acid of the highest concentration and PE in the ratio of 5 to 1 were introduced simultaneously into a nitrator of 54 liter capacity. The PE was added by means of a "dosing" machine feeding at the rate of 600 g every 47 seconds. The temperature was maintained at 15-20° by means of cooling coils

b) The solution-suspension of PETN in nitric acid was led to an after nitrator, where the mixture was maintained at 12°

c) After this it went to a third vessel, where a strong jet of water diluted the acid and precipitated that part of PETN, which was dissolved in the stronger acid

d) The slurry was run through a vacuum filter and the ppt was rinsed several times with water

e) The precipitate was transferred to vessel where it was heated in dilute soda ash soln to 80-85° and from which PETN was run to a 2nd stabilizer

f) After separating the liquor by vacuum filtration, the PETN was washed with water and aspirated to a moisture content of 7-10%

g) The moist material was dissolved in 98% acetone preheated to 56°, and allowed to run gradually and with stirring into a vessel containing cold water

h) The acetone was distilled off and the crystallized PETN separated from the bulk of the water by vacuum. It was then packed in rubber bags and carried to the phlegmatizing house

i) For phlegmatizing (desensitizing) PETN, the Troisdorf Fabrik, D A -G used either Montan Wax, or a synthetic I G Wax - 41a. The amount of wax added to PETN was usually 10%, although mixtures with as high as 60% were known. The crystals of PETN were suspended in cold water containing some common salt in solution. The temperature was raised to about 40° and molten wax was added in a thin stream. The temperature was raised and the mass maintained at the boiling point until about 20% of the water had evaporated

j) The slurry was then cooled (by adding cold water) and filtered. After washing the phlegmatized product with water and removing as much water as possible by suction, the product was dried to reduce the moisture content to below 0.1%. The material was then screened and packed

C) The semi-continuous method as practiced at the Krümmel Fabrik, D A -G was essentially as follows:

a) The nitrating apparatus consisted of 3 stainless steel vessels connected in series. A charge of 200 kg of PE and 1000 kg of 99% nitric acid was fed into the first nitrator (which was cooled with brine circulated in coils and in a jacket) where the main nitration took place at 15-20° during about 10-15 minutes. A second charge of PE and HNO_3 was meanwhile weighed and transferred to the first nitrator immediately after the 1st batch was transferred to the 2nd nitrator (which was also provided with jacket cooling). Following this, the 1st batch was transferred to the 3rd nitrator, the 2nd batch to the 2nd nitrator, and a 3rd charge was introduced into the 1st nitrator, etc. The total time of nitration was about 40 minutes

b) In the 3rd nitrator, the mixture was diluted with water to give a waste acid of about 30% strength

c) After filtering off PETN from waste acid, PETN was washed with water and then digested with soda ash solution in a stabilizing vessel at 60° until the slurry was weakly alkaline (time, about 1½ hours). This was followed by water washing directly on the filters

d) The next operation, crystallization from acetone, was done in a continuous manner in a battery of 6 distillation vessels connected in series. In these vessels, water was added to the solution and the acetone gradually evaporated leaving a water slurry of PETN. After removing the bulk of the water by vacuum filtration, the moist PETN (10% H_2O) was transferred to the wax phlegmatizer

e) Phlegmatization was carried out in a water slurry of 315 kg of PETN (contg 10% H_2O) plus 1200 kg of water at 85°, to which wax, usually Montan or I G Wax -41a, in the proportion of 1 part wax to 9 parts PETN by dry weight, was added with stirring

Note: According to German Railroad regulations, phlegmatized PETN was permitted to be shipped if it contained at least 6% wax. Unphlegmatized PETN required at least 30% of water for shipping.

PETN was also phlegmatized by the addition of TNT (20 to 50%) and the operation was conducted by suspending PETN in about 6 parts of water at 70°, heating to about 80° and adding molten TNT with agitation. This was followed by cooling, filtering and drying. The mixture was allowed to be shipped dry (Ref 1).

The manufacture of phlegmatized PETN at the Wolfratshausen Plant was described by Swanson Ref 3 and CIOS Rept 25-16 (1945).

Abbreviations: PE Pentaerythritol.

References: Same as under Pentritsprengstoffe.

Pentritsprengstoffe (Pentaerithritol Tetranitrate Explosives). Straight Pentrit (PETN) was used under the name of Filler No 3-NP as a bursting charge in some grenades and small shells (such as the 20 to 50 mm), as well as in a lower detonator. Straight PETN was also used in a propellant called Nipolit.

The use of PETN desensitized with 8-10% wax was much more common.

Note. The wax used in German explosives was usually Montan Wax, obtained from the lignites found in many parts of Germany and countries occupied by her during WW II. The properties of Montan wax are comparable to those of Carnauba wax imported from Brazil. German PETN-wax mixtures were usually dyed pink. The explosive properties of such mixtures were the same as those of the corresponding American mixtures described under Pentaerythritol Tetranitrate in the general section.

The principal uses of PETN-wax mixtures were as follows: fillers for various shells, bombs, grenades, and some sea mines; fillers in some shaped charge ammunition; standard boosters in chemical and incendiary ammunition; standard sub-booster in all types of ammunition and as the core in a detonating fuse.

Explosives, desensitized with TNT, are briefly described under Pentol or Pentritol as well as Fillers Nos 16, 18, 28, 32-34, 36, 37, 42 etc). In some mixtures Al was incorporated and these were used in underwater ammunition.

Besides these mixtures there was also a plastic explosive (see Filler No 43) and explosives consisting of PETN, RDX and wax (See Filler No 45).

References:

1) Anon, Allied and Enemy Explosives, Aberdeen Proving Ground, Md, (1946) pp 138-142
2) O.W.Stickland et al, General Summary of Explosive Plants, PB Rept No 925 (1945), pp 42-45
3) A.A.Swanson et al, Manufacture of Phlegmatized PETN, PB Rept No 320 (1945)
4) A.Stettbacher, Spreng- und Schiessstoffe, Zürich (1948), pp 66-67.

Pentritol oder Pentol (Pentolite). See general section and also under Pentrit.

Perchlorate Explosives. See Perchloratsprengstoffe.

Perchloratit (Perchloratite). A type of industrial explosive based on perchlorates. Table 31 gives some perchloratites listed in the book of Naoúm (Ref 1).

Table 31

Ingredients:	Composition, %		
	1	2	3
K perchlorate, of which up to 10% of the total explosive may be replaced with Am nitrate and/or K nitrate	60-75	62-75	-
K and/or Am perchlorate	-	-	30-40
Am nitrate	-	-	35-45
Note: When Am perchlorate is incorporated some of the Am nitrate is replaced by K nitrate in an amount chemically equivalent to the amount of Am perchlorate.			
Vegetable meal	1-5	-	-
Vegetable meal and/or solid hydrocarbon	-	1-8	3-8
Nitroglycerin(ungelatinized)	3-6	-	-
Nitroderivatives of toluene and/or napthalene and/or diphenylamine in which up to 4% of the total explosive may be substituted with nitrocellulose	20-30	20-30	15-20

Stettbacher (Ref 2) lists the following perchloratites:

Table 32

Composition, %	Perchloratites:		
	1	2	3
K perchlorate	68	35	34
Am nitrate	10	42	48
TNT and DNT	-	14	-
DNT	16	-	12
Wood (or vegetable) meal	1	5	6
NG (nitroglycerin)	4	4	-
MNN (mononitronaphthalene)	1	-	-

References:

1) P.Naoúm, Nitroglycerin,etc, Baltimore (1928), p 431
2) A.Stettbacher,Schiess- und Sprengstoffe, Leipzig (1933), p 316.

Perchloratminensprengstoff (Perchlorate Explosive for Trench Mines). According to P.Naoúm,Schiess- und Sprengstoffe (1927), p 133, the following castable mixture, developed during WW I at Zentralstelle für wissenschaftlich-technische Untersuchungen in Neubabelsberg, was found to be suitable for use in Wurfminen (trench mortars): K perchlorate 56, DNB 32 and DNN 12%.
Note: This explosive was called Perdit by Davis (1943), p 364, but on p 118 Naoúm gives a different formulation for Perdit.

Perchloratsprengstoffe (Perchlorate Explosives): Explosives based on the perchlorates of ammonium, potassium or sodium were used to a limited extent in Germany, as for instance: Parammon, Perchloratite, Perchlorit, Perdit, Perkoronit,etc.
(See also Perchlorate Explosives in the general section).
Note: According to Davis p 364 the perchlorates recovered from surplus bombs etc of WW I (see Perchloratminensprengstoffe and also Perdit) were used in the German post WW I commercial explosives, such as Perchloratit, Perchlorit, Perkoronit and Persalit. When the supply of surplus perchlorates became exhausted the manufacture of perchlorate explosives was nearly discontinued because the price of new perchlorates was too high.

Perchlorit (Perchlorite). A type of perchlorate explosive used in mining before and during WW I. Table 33 gives the composition of two perchlorites

Table 33

Ingredients and properties	Composition, %	
	1	2
K perchlorate	35	34
Am nitrate	42	48
DNT*	10	10
DNN	4	0
Wood meal	5	6
Coal powder	-	2
NG	4	-
Oxygen Balance, %	+1.7	+1.7
Trauzl Test, cc	340	340

*DNT was prepd by the nitration of m-MNT.

Reference: Naoúm, Nitroglycerin, Baltimore (1928), p 133.

Perccronit (Percoronite). A blasting explosive which replaced Coronit in soda quarries and ore mines: K perchlorate 65, NG 5, aromatic nitrocompounds 25 and vegetable meal 5%.
Reference: J.Bebie, Manual of Explosives, Macmillan, N Y (1943), p 116.

Perdit (Perdite). An explosive developed during WW I as a replacement for the Corps of Engineers Explosive, (Pioniermunition) Donarit. The composition and properties of Perdit were: Am nitrate 72, K perchlorate 10, wood meal 3 and a eutectic mixture of DNT and TNT 15%; density 1.20-1.25, Trauzl test value 370-380cc, sensitivity to initiation - required at least a No 3 cap for detonation. It was used not only as a demolition charge but also for loading bombs and trench mortar shells.

References:

1) P.Naoúm, Schiess- und Sprengstoffe, Dresden(1927), p 118
2) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 309.

(See Note under Perchloratminensprengstoffe).

Perkoronit (Percoronite). A type of mining explosive manufactured after WW I from K perchlorate recovered from surplus military explosives. Table 34 gives two examples.
(See next page).

Permonit (Permonite). A type of mining explosive manufactured before WW I by the Sprengstoff A-G Carbonit. One such explosive, called Gesteins-Permonit, was described in this section under Gesteinssprengstoffe. Table 35 gives two examples of permonites.
(See next page).

Table 34
(Percoronites)

Components and Properties	1	2
K perchlorate	58	59
Am nitrate	8	10
DNT + TNT + vegetable meal	30	31
NG (nitroglycerin)	4	-
Oxygen Balance, %	+2.2	+1.8
Density	1.58	1.52
Velocity of Detonation, m/sec	5000	4400
Trauzl Test, cc	340	330
Pb Block Crushing, mm	20.0	18.0
Requires for initiation minimum	No 3 cap	No 3 cap
Gap Test, cm	6.0	4.0
Heat of Explosion, kcal/kg	1170	1160
Temperature of Explosion, °C	3145	3115

References:

1) P.Naoúm, Nitroglycerin, etc, Baltimore (1928), p 430
2) T.L.Davis, Chemistry of Powder and Explosives, Wiley, N Y (1943), pp 364-5.

Table 35
(Permonites)

Components and Properties	1	2
K perchlorate	32.5	31-34
Am nitrate	42.5	39-43
NG	-	3-4
Collodion cotton	-	.5-1
TNT	10.0	11-13
Starch	12.0	5-9
Wood meal	3.0	1.5-3.5
Moisture	-	0-2.5
Veloc of Detonation, m/sec	3780	-
Density	1.13	-
Trauzl Test, cc	-	365
Gap Test, cm	-	8.0
Impact Sensitivity (2kg weight)	-	20 cm

Permonites were used in potash and in ore mines. Some permonites were on the British Permitted List and on the Belgian SGP List.
Reference: A.Marshall, Explosives, London, v 1 (1917), p 384 and v 2 (1917), p 493.

Persalit (Persalite). One of the perchlorate mining explosives manufactured from left-over stocks of WW I military explosives. The name Persalit is mentioned in P.Naoúm, Schiess- und Sprengstoffe(1927),p 126, but the composition is not given.

Petroklastit oder Haloklastit. One of the pre-WW I explosives used in potash mines and stone quarries: Na nitrate 69, K nitrate 5, sulfur 10, coal tar pitch 15 and K bichromate 1%, Trauzl Test value 157 cc (vs black powder 108) and Sensitivity to impact with a 2 kg wt 100 cm (black powder 65).
References:

1) A.Marshall, Explosives, London,1 (1917), p 89
2) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 111.

PETN. See Pentrit.

PE-Wolle. A nitrocellulose of 11.25-11.50% nitrogen content, used for the manuf of some smokeless propellants. See Nitrocelluloses and also Propellants.

Pfeilgeschoss. See Arrow Projectile.

Phenanthren (Phenanthrene) was proposed by Römer to be used as one of the ingredients in explosives based on cyclotrimethylenetrinitroamine (R-Salz), such as: R-Salz 96.5, phenanthrene 2.5, and DPhA 1.0%.
Reference: G.Römer, Report on Explosives, PBL Rept No 85,160 (1946), pp 10-13.

Phenix Sprengstoffe (Phenix Explosives) were mining explosives patented in 1899 by the Sprengstoffwerke Dr Nahnsen & Co in Hamburg.
Table 36 gives some examples

Table 36

Ingredients	Composition %				
	1	2	3	4	5
NG	25	25	30	30	30
K nitrate	34	-	-	-	-
Na nitrate	1	35	32	30	32
Sawdust	40	-	38	-	-
Rye flour	-	40	-	40	38

References:

1) Daniel, Dictionnaire, des Matières Explosives, Paris, (1902), p 449
2) L.Gody, Traité des Matières Explosives, Namur(1907), p 715.

Phenol (Phenol). See general section and also BIOS Final Rept 1246 (1946).

Phosphorus Bombs. Some incendiary bombs contained phosphorus. For instance, the 50 kg Brand C50B bomb contained white phosphorus whereas the 50 kg Brand C50A bomb was filled with 30 lb of a mixture containing phosphorus 4, benzene 86 and pure ruber 10%.
Reference: TM 9-1985-2 (1953), pp 54-5.

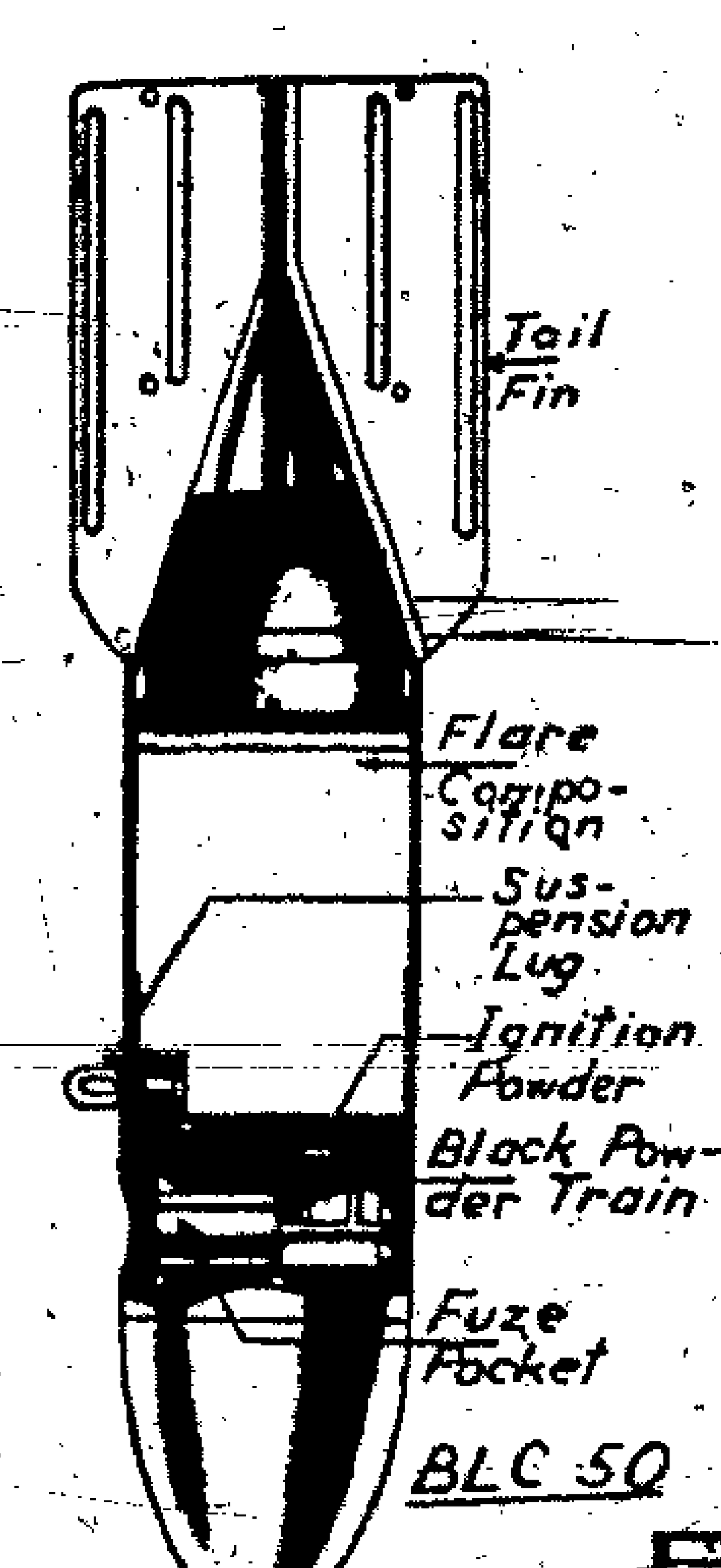
Phosphorus Grenade. One of the incendiary grenades manufd during WW II in Germany was described in BIOS Final Rept 1233 (1946), p 2. It weighed 1390 g and was prepd from a casing weighing 300 g, having a diameter of 105 mm. After filling the casing with a mixture of cotton wool (40 g) and naphthalene (300 g), the air was exhausted and the mouth of the grenade was immersed into molten yellow phosphorus. This operation allowed about 750 g of phosphorus to enter the grenade and impregnate the cotton and naphthalene.

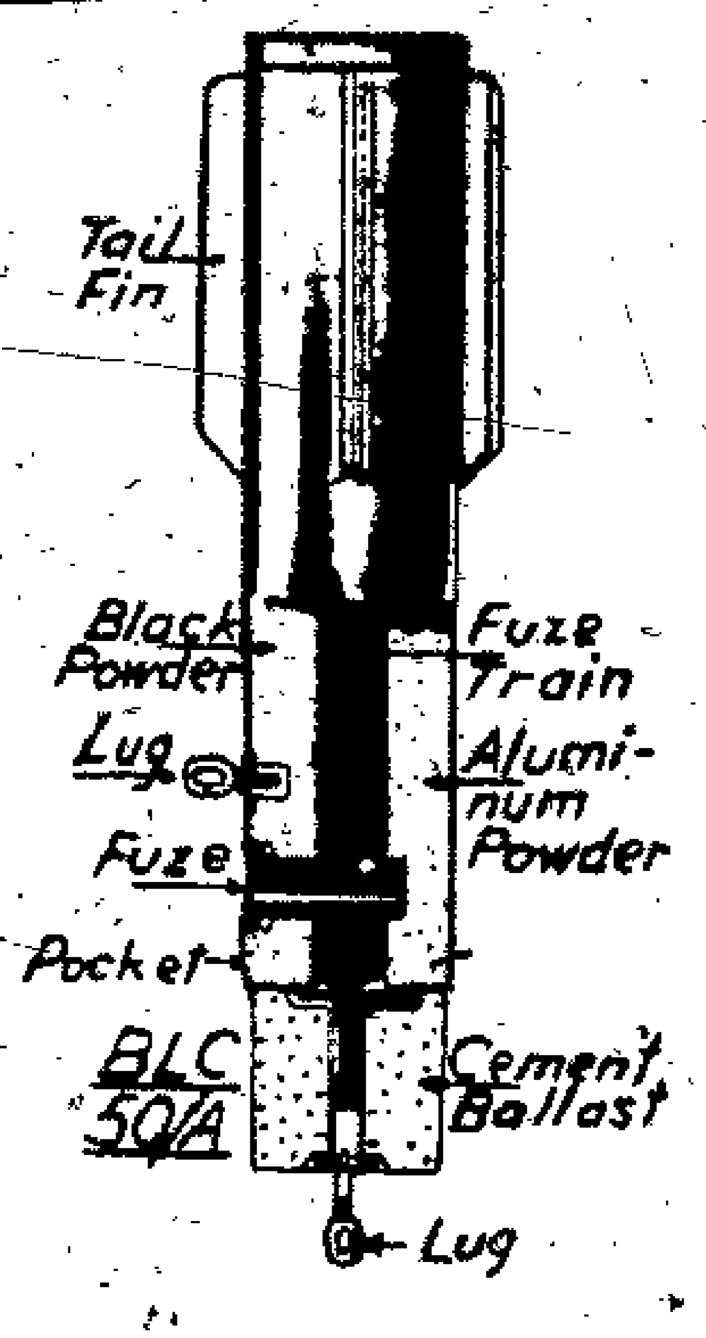
Photoflash Bomb (Blitzlichtcylindrische Bombe, abbreviated as BLC or BIC), called also Photographic Flash Bomb. German bombs were similar in external appearance to conventional 50 kg bombs and parachute flare cases. Their fillings, which could be either flare compositions or incendiary mixtures, were ignited by electrical or mechanical aerial burst fuzes.

Following are examples of photoflash bombs:

a) BLC 50 bomb weighed 30 lb and resembled in appearance the SC kg Type 1 bomb except that the case was made of sheet steel with a heavy nose section. Body diameter 7.8", body length 26.4" and overall length 43.0". (See also under Bombs).

b) BLC 50A bomb consisted of a light steel casing 42.9" long and 8" in diameter. Its nose was filled with





concrete which acted as a ballast to stabilize the flight of the bomb. The outer section of the bomb contained 15 kg of Al Pyroschliff (q v), while the inner tube contained 3.5 kg of black powder, called Marine-Geschütz Pulver. This served for expelling, scattering and igniting the Al powder, which continued to burn in the air. The black powder was exploded by means of an 80 mm long detonating fuse placed inside the tube passing through the black powder charge. The fuse was initiated by means of an electric delay fuse inserted in the fuze well in the side of the bomb. Total weight of the bomb was 42 kg. The bomb was insensitive to bullet impact.

Note: The Pyroschliff aluminum could be replaced with an atomized Al powder called Griess, or by mixtures containing magnesium powder described under Photoflash Compositions.

Reference: TM 9-1985-2 (1953), pp 65 & 81-3.

Photoflash Compositions. Among the compositions used by the Germans, may be mentioned the ones used in the BLC 50/A bomb:

a) 15 kg of flaked aluminum, called Pyroschliff (q v). It was insensitive to bullet impact and had the following characteristics: peak light intensity 450 million Hefner candles, time to reach peak intensity 70 milliseconds and total light output 63 million international candle seconds

b) 30 kg of atomized aluminum, called Griess (q v). It was insensitive to bullet impact and had a peak light intensity of 800 million Hefner candles. The time to reach peak intensity and the total duration of the flash were longer than for the 15 kg Pyroschliff

c) 28 kg of pellets (13 mm diam and 7 mm heigh) composed of magnesium powder 39, Ba nitrate 53, synthetic phenolic resin, 6 and talcum 2%. It was sensitive to rifle bullet impact. Its peak intensity was 80% of that of Pyroschliff, and the time to reach peak intensity was 100 milliseconds.

d) 28 single-perforated pellets (60 mm diam and 220 mm high), each weighing 900 g (total weight of pellet 25.2 kg) and consisting of Mg powder 50, Na nitrate 45 and wax 5%. A length of detonating fuse was passed through each pellet, and the ends of the fuse bound together. It was sensitive to rifle bullet impact and had a peak intensity (measured through a yellow filter) 20% greater than for 15 kg of Pyroschliff. The time to reach peak intensity was the same as for Pyroschliff, but the duration of flash much longer.

Reference: TM 9-1985-2 (1953), pp 82-4.

PH-Salz (PH-Salt). German name for Ethylenediaminedinitrate (EDDN), described in the general section. In Germany PH-Salz was prepd by treating ethylenedichloride with ammonia and NaOH, followed by nitration with nitric acid not stronger than 50%. Although PH-Salz has a high m.p. (185°), it has the property of depressing the m p of other high m p compounds. For this reason, the Germans used it to obtain castable explosive mixtures. For instance, a mixture of 45% PH-Salz and 55% Am nitrate melts at 105° and can be cast-loaded. Such a mixture has an explosive power equal to that of TNT or Amatol, but it has the disadvantage of shrinking considerably on cooling. Addition of aqueous Ca nitrate to this mixture practically eliminates shrinkage and results in a very good cast. The following mixtures contg PH-Salz were used for filling some shells as a substitute for TNT.

a) Ammonit: NH_4NO_3 46, PH-Salz 46 and $Ca(NO_3)_2$-$4H_2O$ (tech) 8%; density of fragments 39-40 m. (See Fragments Density Test)

b) Ammonit: NH_4NO_3 55, PH-Salz 10, $Ca(NO_3)_2.4H_2O$ 10, RDX 20, and $NaNO_3$ 5%; d 1.53, casting temp 108°, density of fragments 40 m (Ref 3)

c) H-5 (Ammonit): PH-Salz 10, NH_4NO_3 50, $NaNO_3$ 5, $Ca(NO_3)_2.4H_2O$ 15, and RDX 20% (Ref 2)

d) S-16: PH-Salz 10, NH_4NO_3 32, $NaNO_3$ 6 or 8, KNO_3 2 or 0, RDX 10 and Al (powder) 40% (Ref 2)

e) S-22 (Hexo): PH-Salz 14, NH_4NO_3 45, $NaNO_3$ 9, KNO_3 3, RDX 14, and Al (powder) 15% (Ref 2)

f) S-22 (Hexa): PH-Salz 14, NH_4NO_3 45, $NaNO_3$ 9, KNO_3 3, HNDPhA 14, and Al (powder) 15% (Ref 2)

g) Amatol 41: NH_4NO_3 52, PH-Salz 30, $Ca(NO_3)_2$-$4H_2O$ 6, RDX 10 and Montan wax 2% (Ref 3).

Compositions containing Al were particularly suitable for underwater weapons because they possessed high blast effect. PH-Salz could also be used straight or slightly phlegmatized. In the latter case, it was particularly suitable for use in anticoncrete shells, called Be-Granate (Be is the abbreviation for Betonconcrete).

References:

1) PB Rept No 925 (1945), p 24
2) PB Rept No 1820 (1945), p 29
3) PBL Rept No 85 160 (1946), p 23.

Picric Acid. See Pikrinsäure.

Piercing or Penetration Test. For this test an explosive enclosed in an iron tube, 30 mm in diameter and 100 mm long with walls 3.5 mm thick, was detonated horizontally against a lead sheet 30 mm thick with sides 100 mm long. The penetration produced was compared with that of a standard explosive such as TNT.

Reference: G.Römer, PBL Rept 85160 (1946), p 10.

Pike (Hecht) Missile. An experimental guided missile developed in 1941 by the Rheinmetall-Borsig Co.

Reference: K.V.Gatland, Development of the Guided Missile, London, (1952), pp 116-17.

Pikrinsäure (Picric Acid) (P A). Methods of preparation and properties are given in the general section. It would be of interest to know that in 1892 the Chemische Fabrik Griesheim, Ger, Pat 69 837, developed a unique process for loading HE shells with P A. This was carried out as follows: a mixture of P A and 5 to 10% of TNT was placed in a suitable mold which was heated for a short time to a temperature of about 82°C which is slightly above the m p of TNT. On cooling there was formed a solid block consisting of crystals of P A cemented to the thin intermediate layers of solid TNT. In place of TNT other solid nitrocompounds with not too high a m p may be used (such as DNT, DNPh, DNCrs, TNCrs, DNB, nitrated naphthalenes, xylenes, etc). It was claimed that the resulting explosives had high density, were safe to prepare, and were appreciably less sensitive to a mechanical action than a straight P A (see Ref 1).

During WW II P A was manufactured for use as a booster (compressed), as well as a filler for some shells, land mines, depth charges (see Filler No 2) and as a filler in stick hand grenades (see Filler No 5).

Cast P A was used under the name of Filler No 24.

Abbreviations: DNB Dinitrobenzene; DNCrs Dinitrocresol; DNPh Dinitrophenol; DNT Dinitrotoluene; TNCrs Trinitrocresol and TNT Trinitrotoluene.

References:

1) E. de W. Colver, High Explosives, Van Nostrand, N Y, (1918), pp 319-20 & 697
2) Anon, Allied and Enemy Explosives, Aberdeen Proving Ground, Md, (1946)
3) A.Stettbacher, Spreng- und Schiessstoffe, Rascher, Zürich (1948), pp 75-77.

Pilsit. See Silvit.

Pirat (Pirate). A solid propellent rocket used as an assisted take-off unit for Feuerlilie-55. [TM 9-1985-2 (1953), p 226].

Pistol (Pistole). See under Weapons.

Pistolenpulver (Pistol Propellant). The following composition is given in Brunswig, Das rauchlose Pulver, (1926) p 136: guncotton 96, Ba nitrate 1, DPhA 1.5, residual volatile gelatinizer 0.5 and moisture 1%.

Pistol Grenades (Pistolengranaten). Several types of German grenades were fired from special pistols, such as the 27 mm Walther signal pistol, etc.

Following types of pistol grenades are described in TM 9-1985-2 (1953), pp 340-46:

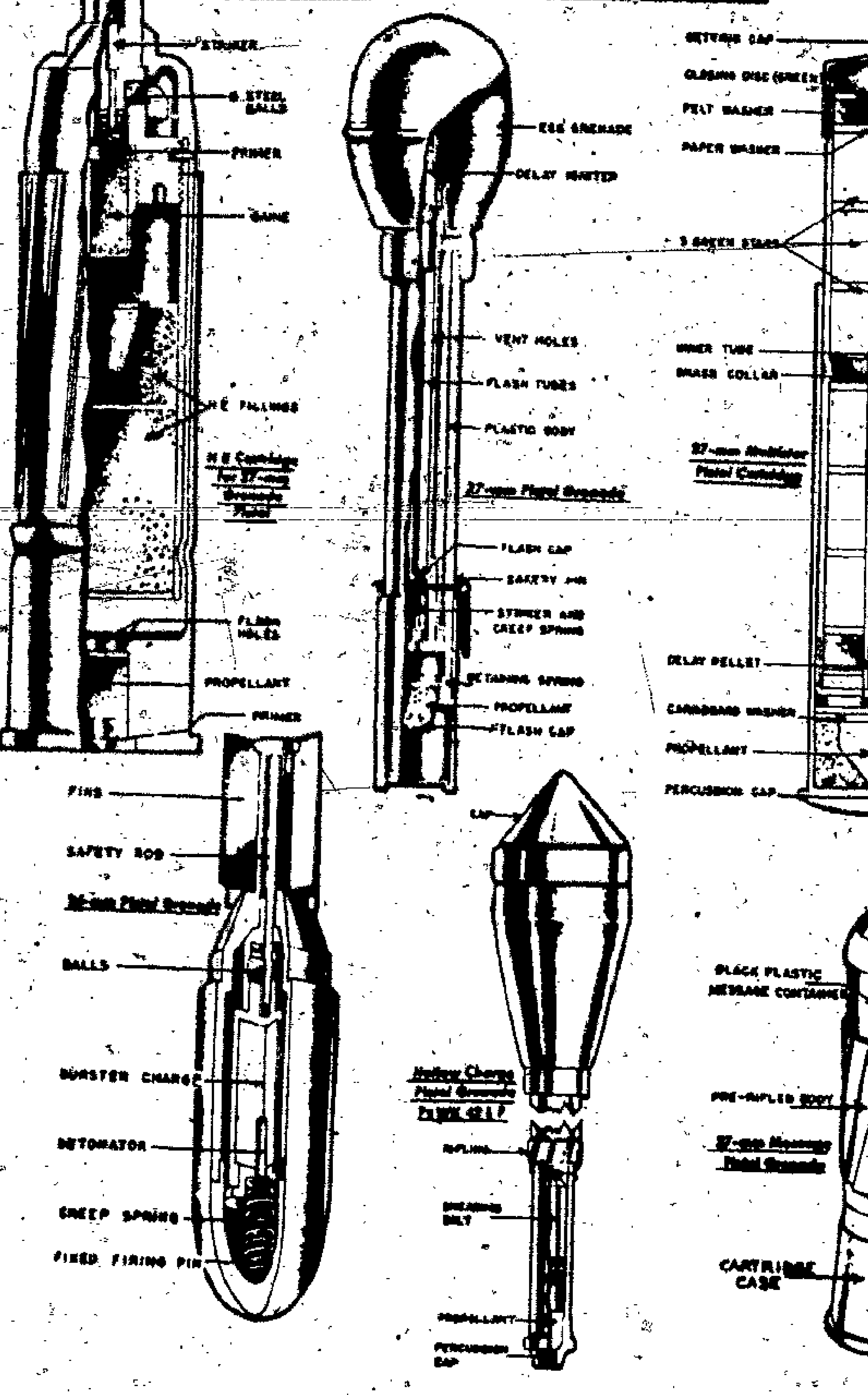
a) Pistol Grenade (Wurfkörper für Leuchtpistole 361) consisted of a normal egg hand grenade attached to a plastic stem (body) by a retaining tube. The plastic stem contained the firing pin, delay igniter, detonator and a base adapter for the propellant. The end of the stem was closed before firing by a cardboard cap. After arming the grenade by withdrawing the safety pin, the plastic stem was placed in a barrel reinforcing tube which was previously placed in the barrel of the 27 mm Walther signal pistol. The cap and the propellant in the rear section of the stem were fired and the grenade went towards its target (maximum range 80 yds). The impact of the grenade caused the firing pin to strike the primer and the resulting flash ignited (through the flash tubes) the delay igniter. After a delay of about 4.5 sec the grenade exploded (pp 340-1)

b) 27 mm Egg Type Pistol Grenade, described on pp 341-2, was fired from the latest type 27 mm Walther signal pistol, without the insertion of a rifled liner (as a reinforcing tube) in the barrel. The grenade was similar to the type 361 except in the construction of the stem

c) 26 mm Pistol Grenade (Wurfgranatepatrone), fired from the smooth-bore pistol, 326 Leuchtpistole, consisted of a projectile having the appearance of a small mortar shell. A brass cartridge case, containing about 0.1 ounce of rifle propellant, was crimped over the rear section of the grenade where the fins were located. The projectile itself consisted of an outer casing (body) and a loosely inserted inner casing containing the detonator and the main charge. The fixed firing pin, held by a creep spring, was located in the nose section of the body. The inner case was prevented from moving forward before firing by two metal balls fitting into a hole in the tail section of the projectile and resting in grooves. An arming (safety) rod fitted between the balls holding them apart. The withdrawal of the rod, caused by the setback on firing the projectile, allowed the retaining balls to move towards the center thus releasing the rear section of the inner case. The case would now be free to move forward if it was not held by the tension of the creep spring. This tension was overcome on impact thus allowing the detonator (contained in the inner case) to move forward and strike the fixed firing pin (pp 342-3)

d) 27 mm HE Grenade (Sprengpatrone) for the rifled pistol (Kampfpistole) consisted of a die cast aluminum body provided on the outside with five grooves making one quarter turn of the projectile. Inside the body was a steel cylinder containing two PETN/wax pellets separated by a cardboard disc. The nose section contained the direct action fuze fitted with a protruding striker head. The striker was held away from the fuze primer by 6 steel balls which rested in the groove of the striker and on a platform of the fuze. The balls were kept in position by a steel collar which was supported on three aluminum pins. A creep spring was located between the striker and the primer, and beneath the primer was an aluminum gaine containing in the upper part a mixture of lead azide and lead styphnate and in the lower part pressed PETN. Between the gaine and the main filling there was an air space. The propellent charge was contained in a cup which was placed in the cartridge attached to the tail section of the grenade. There were 10 holes in the cup to lead the propellent gases to the base of the grenade. On firing, the gases propelled the grenade and rotated it because of the rifling. The setback caused the collar in the fuze to move back crushing the aluminum pins and the centrifugal force caused

PISTOL GRENADES



the balls to fly outward. This partly freed the striker, but it still was held by the creep spring until the striker head hit a solid object (pp 343-4)

e) 23 mm Hollow Charge Signal Pistol Grenade, PzWK 42 LP (Panzerwurfkörper 42 für Leuchtpistole) was fired from the 27 mm Walther signal pistol fitted with a 23 mm rifled liner, a special sight and a folding butt. The warhead of the grenade was pear-shaped and contained the shaped charge and an impact cap. To the rear of the warhead was attached the tube containing the graze fuze-detonator and the gaine. A short length of this tube was prerifled. A thinner tube containing a shearing bolt, propellant and a percussion cap was attached by a shear pin to the prerifled section. On firing, the propellent gases drove the shearing bolt forward causing it to break the shear pin. This released the grenade and armed the graze fuze (by setback) (pp 344-5)

f) 27 mm Pistol Grenade Message was fired from a 27 mm rifled signal pistol (Kampfpistole). The round consisted of a prerifled aluminum cylinder (containing a smoke generator, a colored silk streamer and an ejection charge), a black plastic head (containing a message or other small object) and an aluminum cartridge case. On firing, the flash from the propellant ignited the delay pellet in the grenade base plate and this, in turn, ignited the ejecting charge which expelled the message container, silk streamer and smoke generator. (p 345)

g) 27 mm Multistar Signal Cartridge fired from a signal pistol, consisted of a light alloy outer cylindrical casing (the base of which contained the propellant and percussion cap) and an inner cylinder which contained six green and red star units. Running through the center of the star units was an assembly of two concentric brass tubes which were held in position by a central cannelure into which the inner cylinder was indented and fixed by means of a steel pin. The outer brass tube had one set of 6 flash holes adjacent to the inner surfaces of the six stars. The inner brass tube also had a set of flash holes which by means of a setting cap could be aligned so as to permit the ignition of a selected number of combinations consisting of red and green stars as shown below:

a) 3 red & 3 green, b) 1 red & 2 green, c) 3 red & 1 green, d) 1 red & 3 green, e) 2 red & 2 green and f) 2 red & 1 green.

The inner brass tube was filled with black powder and was closed at the lower end by a screwed plug which contained a delay pellet.

In firing, the inner cylinder was ejected (by propellent gases) from the outer light alloy case, and, after the delay pellet had burned through the flash passed immediately along the whole length of the inner brass tube, igniting and ejecting the stars in accordance with the setting. The stars which were not ignited fell to earth intact (pp 346-7).

Plastic Explosives. Several plastic explosives based on PETN and RDX were used in Germany during WW II. One of the earliest compositions consisted of RDX treated with American vaseline (see Note) until this vaseline became unavailable. Thereafter mixtures called Plastit and Hexaplast, which did not contain vaseline, were used.

Note: American vaseline was considered most suitable because it is "long fiber" and can be stretched like dough to form threads. European vaseline, such as the Russian, is not tacky and does not produce good plastic explosives. (See also Plastic Explosives in the general section).

Reference: PB Rept 925 (1945), pp 74 & 77.

Plastics. (Kunststoffe, Pressstoffe). Manufacture and properties of plastics are described in the following References:

1) W. Krannich, Kunststoffe im technischen Korrosionsschütz, Lehmann, München-Berlin (1943)
2) H.S. Bergen, PB Report 7032 (1943)
3) Anon, PB Report 91836 (1945)
4) BIOS Final Reports: 282, 433, 445, 926, 1191, 1246 and 1729 (After WW II)
5) BIOS Miscellaneous Reports: 1, 85, 87 and 98 (After WW II)
6) CIOS Reports: 29-62, 32-26 and 33-23 (After WW II)
7) H. Sachtling u W. Zebrowski, Kunststoff-Taschenbuch, Hanser, München (1952).

Plastics in German Ordnance. During WW II there was a growing use of plastics in plants which manufactured acids, explosives and ammunition. For instance, linings for tanks and pumps, funnels, pipes, plastic trays for drying explosives, sealing plugs in delay detonators etc, were fabricated from plastic material. One of the plastics developed in Germany was Mipolam. Others were Novolac, Lignofol, Igelitpulver, Trolitul etc.

Reference: PB Rept No 925 (1945), pp 7 and 25.

Plastit A plastic explosive of WW II: RDX 64, collod cotton 3.5 and liquid or semi-liquid nitrohydrocarbons 32.5%. It was less efficient than the American Composition C2 because it contained less RDX [Allied and Enemy Explosives, Aberdeen Proving Ground (1946), p 127].

Plastol, Celludol, Celludin oder Camphrosol Trade names for p-Toluenesulfamide, $CH_3C_6H_4SO_2NH_2$, white flakes, m p 137°, obtained as a by-product of saccharine manufacture. Its 20% alcoholic solution gelatinizes collod cotton completely at 55°.
[Kast-Metz, Chemische Untersuchung, Braunschweig (1944), p 163].

Plastomenit (Plastomenite). According to Daniel (Ref 1) plastomenites were propellants invented about 1889 by Güttler. They consisted of mixtures of the nitrated products of cellulose, sugar, starch, aromatic compounds, etc with oxidizing substances such as inorganic nitrates, chlorates, chromates, etc. These compositions were modified beginning 1897 by incorporating 0.5 to 10% of colophony.

According to Marshall (Ref 2), Plastomenite was an early (1889) sporting smokeless propellant prepared by gelatinizing NC with DNT.

Colver (Ref 3) stated that Plastomenite was a German propellant prepared by blending 5 parts of molten DNT with one part of nitrolignin and sometimes small amounts of Ba nitrate. After incorporation the fused mass was granulated.

Brunswig (Ref 4) gave Plastomenit as containing guncotton 67, Ba nitrate 13, TNT 13, DNT 6 and moisture 1%.

References:

1) Daniel, Dictionnaire des Matières Explosives, Paris (1902), p 634
2) A. Marshall, Explosives, 3, (1932), p 98
3) E. Colver, High Explosives (1918), p 169
4) H. Brunswig, Das rauchlose Pulver (1926), p 134.

Plastrit. See Plastrotyl.

Plastrotyl or Plastrit. According to Colver, High Explosives (1918), p 249, plastrotyls were plastic explosives patented by C.E. Bichel in 1906 (Ger P 181 574). They were prepd by mixing 85 to 87 parts of TNT with liquid or solid resins, such as copaiba balsam, benzoin gum or styrax, with or without liquid DNT. The plasticity could be increased by incorporating some collod cotton. Table 37 gives some examples.
(See next page).

Plattenbeschuss (Plate Shooting). A plate test for the estimation of the brisance of explosives similar to the one described in the general section.

Table 37

Ingredients	% Composition			
	1	2	3	4
TNT	87.0	85.0	85.0	85.0
Copaiba balsam	12.0	-	-	-
Larch turpentine	-	14.0	-	-
Liquid styrax	-	-	4.5	-
Benzoin gum	-	-	-	4.5
Liquid DNT	-	-	10.0	10.0
Collod cotton	1.0	1.0	0.5	0.5

Platzpatronenpulver (Blank Cartridge Propellant). The following composition is given in Brunswig, Das rauchlose Pulver (1926), p 136: collod cotton 23, guncotton 74, diphenylamine 0.7, soot 0.3, moisture 1.0 and residual volatile gelatinizer 1.0%.

PMF-109. Same as Füllpulver 109 (Fp 109), described under Filler.

POL (Pulver ohne Lösungsmittel) (Solventless Propellant). See under Propellants.

Pollopas One of the plastic materials developed prior to WW II by the Dynamit A-G, at Troisdorf. It is a urea-formaldehyde condensation product.

References:
1) V.Kraenich, Kunststoffe in Technischen Korrosionsschütz, Lehmann, München-Berlin (1943), p 21
2) H.Saechtling & W.Zebrowski, Kunstoff-Taschenbuch, C.Hanser, München (1952), pp 240 & 254
3) H.A.Tisch, Picatinny Arsenal; private communication.

Polpulver. See POL

Polyamide. According to CIOS 21-3 (1945), a Nylon type polyamide was developed at the Troisdorf Plant of Dynamit A-G. No description of its manuf and properties is given.

Polyglykol (PGK) (Polyglycol). A liquid product consisting of about 75% diethyleneglycol (DEG), called in Germany Diglykol, and 25% ethyleneglycol (EG) called Glykol (GK). This product was manufd before and during WW II by I G Farbenindustrie starting with ethylene which in turn was obtained either from blast furnace gases (by liquefaction and subsequent fractionation) or by hydrogenation of acetylene. This means that no food materials were required for its manufacture, whereas for the manufacture of glycerin critical food materials such as fats were required.

When this product was nitrated, a liquid explosive was obtained which proved to be a better gelatinizer for NC than NG. Another advantage of nitrated polyglycol (NPGc) was that it produced much cooler propellants (possessing lower calorific value) than was ever possible with NG. (See "G" Pulver).

Reference: O.W.Stickland et al, General Summary of Explosives Plants, PB Rept No 925 (1945), p 13.

Polygon. A plastic composition which when applied to the surfaces of combustible solids prevented them from burning. It was used for coating the non-burning surfaces of solid rocket propellants.

Reference: TM 9-1985-2 (1953), p 201.

Polystyrene Plastics. According to CIOS 21-5 (1945), p 5, the IG Farbenind at Ludwigshaven produced two types of polystyrene which softened at 64° and 72° respectively. No copolymers of styrene were used.

Polyurethane Plastics. Preparation and properties are described in CIOS Report 29-12 (1945).

Polyvinylcarbazol Plastic, called Luvican, was unsatisfactory for injection molding because of its high melting point (over 200°). Considerable pressure was required to mold it and this caused rapid wear of the molds.

Reference: CIOS Rept 21-5 (1945), p 5.

Polyvinyl Chloride (PVC) was used in Germany for the preparation of various plastics (Ref 1) and in some pyrotechnic compositions (Ref 2).

The following polyvinyl chloride plastics are mentioned in Ref 1:

a) Vinidur (q v)
b) Mipolam (q v)
c) After-chlorinated PVC. It contained up to 60% of Cl and was very stable. It dissolved in methylene chloride in which the original PVC was not soluble.

References:
1) M.F.Fogler – F.J.Curtis, CIOS Rept 21-5 (1945), p 5
2) T.Urbanski, Przemysl Chemiczny, 27 (4), 487 (1948).

Porofor N. Code number for the product prepd by IG Farbenindustrie by condensation of acetone with sodium cyanide and hydrazine sulfate, followed by treatment with sodium hypochlorite:

$$2(CH_3)_2O + 2NaCN + H_2N.NH_2\ H_2SO_4 \longrightarrow$$

$$(CH_3)_2C(CN)NH\text{-}HN(NC)C(CH_3)_2 \xrightarrow{NaOCl}$$

$$\longrightarrow (CH_3)_2C(CN)N{=}N(NC)C(CH_3)_2$$

The product was used in the manufacture of porous materials such as foam rubber sponge and as a coating for Schnorkel tubes and submarine periscopes (see under Zell-Igelit). It has the property of evolving nitrogen when heated together with vinyl chloride in an autoclave at 130°.

Similar properties were displayed by Porofor DB (Diazoamidobenzene) and Porofor 254 (prepd similarly to Porofor N by using cyclohexanone instead of acetone).

Reference: CIOS Report 25-18 (1945), p 30.

Potato Masher or **Stick Hand Grenade** (Stielhandgranate) consisted of a wooden stick (handle) to which was attached a metallic can filled with an explosive. A similar type was the Japanese Type 98 Stick Hand Grenade and also the Russian Stick Hand Grenade.

Reference: TM 9-1985-2 (1953), pp 319-320 (Stielhandgranaten 24, 39 and 43).

Powder Metallurgy. See Pulvermetallurgie.

Pre-engraved Projectile. See general section.

Pre-rifled Projectile. See Rifled Projectile.

Pressing of Explosives. German procedure is briefly described under Krümmel Fabrik, Dynamit A-G, Pressing of Explosives, etc.

Pressling. C.Monard et al, Mém poud 34, 179 (1952) stated that Pressling was a German explosive of WW II containing some tetranitrosulfoxydiphenylamine,

$$(O_2N)_2C_6H_2\begin{smallmatrix}NH\\SO\end{smallmatrix}C_6H_2(NO_2)_2\ ,$$

a yellow solid with m p 368°. The tetra compd was prepd by nitration and oxidation of thiodiphenylamin (phenthiazine)

$$C_6H_4\begin{smallmatrix}NH\\S\end{smallmatrix}C_6H_4$$

with concd nitric acid. No other information is given by Monard.

Primärladung (Primary Charge) is a top charge of a blasting cap or detonator. Explosives used for primary charges are described under Primary and Initiating Compositions.

Primary and Initiating Compositions. The following German terms are used in connection with this subject: Zündladung (Primer Charge), Zündhütchen (Primer Cap), Initialsatz (Initiating Composition), Initialzünder (Initiator). A general description of primary and initiating explosives may be found in Refs 1, 2, and 8 as well as in the general section. In Refs 4, 5, 6, 7, and 8 are listed explosives used during WW II. Mercuric fulminate was used extensively during WW I, but only in a few types of primers during WW II. Table 38 lists some German primary and initiating compositions used in fuzes, primers and detonators.

Table 38

	Composition %									Uses
	M F	L A	L St	Sb_2S_3	Tetracene	NC	Ca silicide	Oxidizer	Abrasive	
a	23.5	-	-	23.5	-	-	-	$KClO_3$ 43.0	Glass 10	Primers in shells and some bomb fuzes
b	-	-	94	-	-	6(*)	-	-	-	Electric fuze primers
c	-	-	88.7	-	-	11.3(*)	-	-	-	Same as above
d	-	-	37.5	7.4	4.2	-	12.4	$Ba(NO_3)_2$ 38.5	-	Primers
e	-	-	49.1	-	-	-	15.4	$Ba(NO_3)_2$ 35.5	-	Primers
f	-	-	52.1	-	-	-	-	$Ba(NO_3)_2$ 47.9	-	Primers
g	-	82	-	7	-	-	-	-	Glass 11	Primer-detonators
h	-	60	40	-	-	-	-	-	-	Standard detonators
i	-	55	45	-	-	-	-	-	-	Same as above
j	-	14.4	85.6	-	-	-	-	-	-	Detonators

*In compositions (b) and (c) the NC was made into a paste using amyl acetate. Then the paste was beaded to the ignition bridge of a primer.

Table 39 lists some cartridge case primer compositions used during WW II

Table 39

Composition %	Uses
L St 88.7 and NC lacquer 11.3	50 mm HE, 50 mm APRN, 50 mm APHV, 75 mm HE and 75 mm APC
$KClO_3$ 35, Sb_2S_3 37, M F 21.5 and abrasive 6.5	20 mm HESD, 20 mm APLC, 50 mm APC IC, 50 mm APC SC, 50 mm APHV LC, 88 mm HEMTF and 88 mm APC
$KClO_3$ 44, Sb_2S_3 24, M F 23 and abrasive 9	37 mm HE, 37 mm HEMB, 37 mm APRN, 37 mm APHV and 105 mm HE How
$KClO_3$ 28.2, Sb_2S_3 31.1, M F 25.7 and abrasive 15	47 mm AP, 47 mm APRN, 47 mm APHV NP and 47 mm HE
$KClO_3$ 29.1, Sb_2S_3 43.4, M F 16.7 and abrasive 10.8	47 mm HE
Ba nitrate, L St and abrasive	20 mm APHV
Ba nitrate 47.9 and L St 52.1	7.92/13 mm HE
L St 19.2, Sb_2S_3 6.1, Pb-nitrate 53.6 and abrasive 21.1	80 mm CM
L St 26.4, Sb_2S_3 18.2, Pb-nitrate 50.1 and abrasive 5.3	50 mm TM

Table 40 lists some primer compositions used in fuzes during WW II.

Table 40

Composition %	Uses
$KClO_3/Sb_2S_3$	20 mm HE Shell
$KClO_3$ 61, Sb_2S_3 33 and abrasive 6	37 mm APMB, 37 mm APRN, 47 mm APRN, 50 mm HETM, 50 mm APC LC, 50 mm APRN, 50 mm APC SC, 80 mm CM and 88 mm AP Shells; some Land Mines
$KClO_3$ 58.5, Sb_2S_3 27.5, carbon 9.5 and abrasive 4.5	47 mm AP and 75 mm APC Shells
$KClO_3$ 40, M F 29 and Sb_2S_3 31	47 mm HE Shell
$KClO_3$ 45, Sb_2S_3 34, M F 12 and abrasive 9	47 mm HE Shell and 105 mm How Shell
$KClO_3$ 29.5, Sb_2S_3 54.6, carbon 10.7 and abrasive 5.2	75 mm HE Shell
L A 65 and Ca silicide 35, over PETN	75 mm HoC and 105 mm HoC Shells
$KClO_3$ 37, M F 26, Sb_2S_3 30 and glass 7	88 mm AP Shell
$KClO_3$ 51, Sb_2S_3 24 and abrasive 25	50 mm Mortar Shell
$KClO_3$ 38, M F 14, Sb_2S_3 42 and glass 6	Land Mine (Tellermine 35)
L St 41, Ba nitrate 41, Sb_2S_3 3 and Ca silicide 15	Land Mines (Tellerminen 42 and 43)

Abbreviations: AP Armor-piercing; APC Armor-piercing, capped, CM Chemical mortar; HE High explosive; HoC Hollow charge; How Howitzer; HV Hypervelocity; I Incendiary; IC Inert charge; L A Lead azide; LC Long case; L St Lead styphnate; MB Monoblock; M F Mercuric fulminate; MTF Mechanical time fuze; NC Nitrocellulose; PETN Pentaerithritol tetranitrate; RN Round nose; SC Short case; SD Self-destroying; TM Trench mortar.

During WW II, the Germans also developed several types of gasless delay detonators with fuseheads containing lead picrate, among other ingredients. (See Fuseheads A6 and G3 and Fusehead Manufacture).

References:
1) R.Escales, A.Stettbacher, Initial Explosivstoffe, Veit, Leipzig (1917)
2) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933) pp 324 335 .
3) Anon, Allied and Enemy Explosives, Aberdeen Proving Ground, Md (1946), pp 64 & 71
4) Collective, PB Rept 11,544 (1945), part III, Tables I, II and III
5) W.R.Tomlinson Jr, Pic Arsn Tech Rept 1555 (1945)
6) F.Pristera, Picatinny Arsenal Chem Lab Rept No 127,024 (1949)
7) Anon, Army Ordnance 31, No 161, pp 451-2 (1947), German Electric Primers of WW II
8) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 95-109.

Primary Compositions described in TM 9-1985-3 (1953), pp 353-9 were used in the following primers:

a) Percussion Primer C/12nA, used in 50 mm QF cartridges for HE shell, contained: M F 28, K chlorate 34, Sb sulfide 32, and glass powder 6%. The upper recess (magazine) of the primer contained 0.65g of granular black powder and a 1.44g pellet of black powder which served to ignite the propellant (pp 354-5).

b) Percussion Primer C/13nA used in QF cartridges, contained: M F 52.0, K chlorate 23.0, Sb sulfide 19.7 and abrasive 5.3%. The upper recess of the primer housed 8.7 grains of black powder which served to ignite the propellant (p 355)

c) Percussion Primer C/33, used in QF cartridges, contained: M F 24.6, K chlorate 37.6, Sb sulfide 29.6 and abrasive 8.2%. The upper recess of the primer housed 8 grains of black powder, which served to ignite the propellant (pp 355-6)

d) Percussion Primer M 33, used in 47 mm cartridges, contained: M F 16.7, K chlorate 29.1, Sb sulfide 43.4 and abrasive 10.8%. A charge of black powder (3.1 g), placed above the primer, served to ignite the propellant (p 357).

In CIOS Rept 33-20 (1946), p 37 is described in the following primary composition used in caps for 7.92 mm steel cartridges manufd by the Deutsche Waffen- und Munitions-Fabriken A-G, Lübeck: Ba nitrate 42, Pb styphnate 40, Tetracene 3, Pb peroxide 5 and Ca silicide 10%.

Abbreviations: C Construction; HE High explosive; K Potassium; M F Mercury fulminate; nA New Pattern; QF Quick-firing; Sb Antimony.
(See also Abbreviations under Table 40).

Primer (Zündhütchen). According to E.Englesburg, The Ordnance Sergeant, May 1944, pp 320-1, German Artillery primers were all threaded on the outside and were screwed into the base of a cartridge case. The primers were small in comparison with those used in U S ammunition, and contained only a small amount of explosive to amplify the action of the initial fire. To facilitate ignition and to insure complete and uniform burning of the propellant, an igniter bag was employed at the base of all propelling charges whether fixed or semi-fixed.

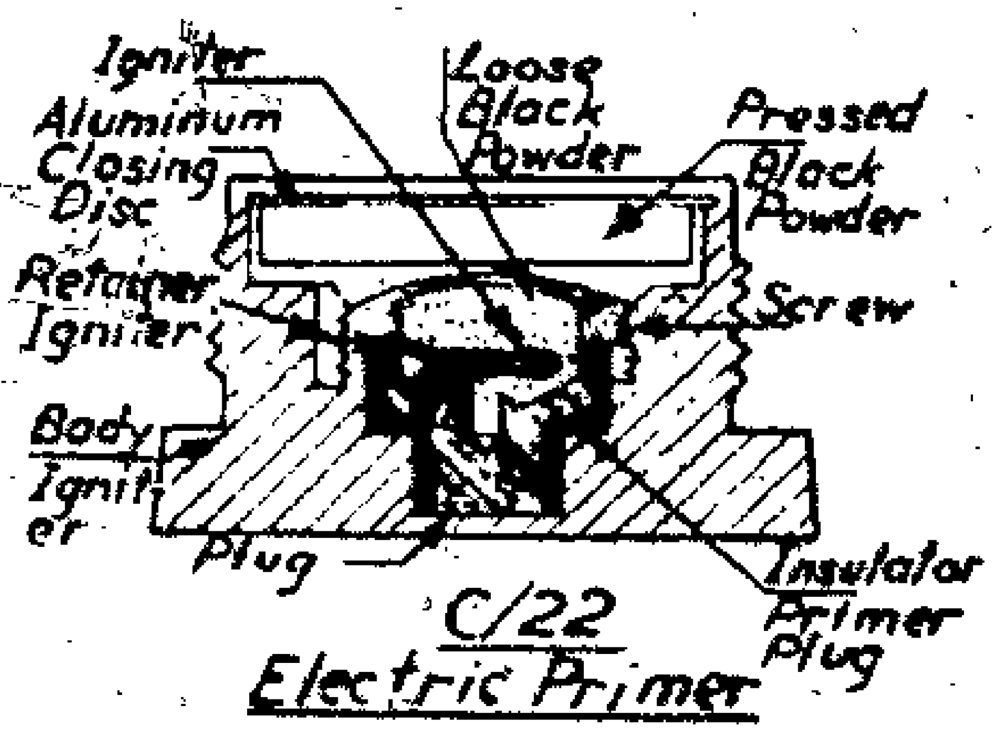
Note: No separate-loading ammunition (such as in the U S A) was used by the Germans.

The body and the inner components of a primer were originally made of brass, but there was a tendency during WW II to make the bodies of steel.

Two types of Artillery primers were used: electric and percussion.

A. Electric primers were employed in all ammunition for anti-tank guns above 5 cm in caliber, for tank guns of 5 cm and larger, for the 7.5 cm StuG, for the 8.8 cm FlaK 41 & 43 and for all calibers of anti-aircraft guns larger than 8.8 cm.

The C/22 Electric Primer consisted of a brass primer body, a plastic primer plug insulator, a brass primer plug, an igniter assembly, a sheet brass igniter retainer,



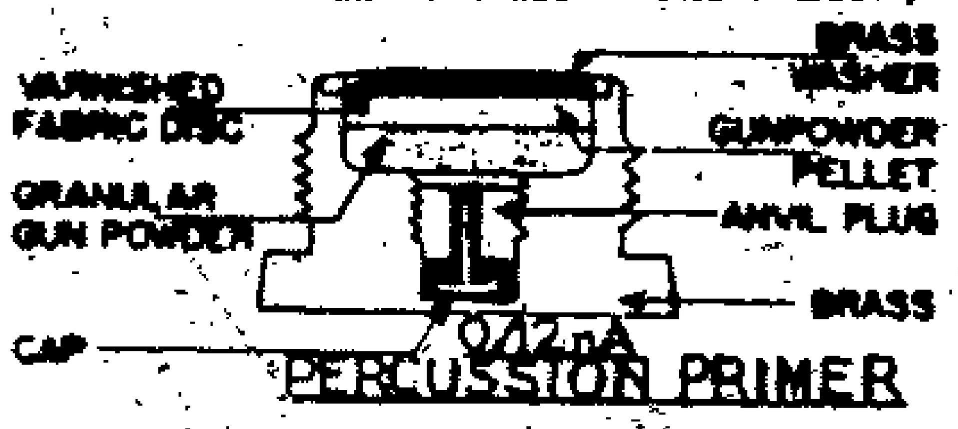
C/22 Electric Primer

a brass retaining screw, a loose black powder charge, a pressed black powder charge, a cloth black powder disk, and an aluminum closing disc crimped in position to close the forward end of the primer. The igniter assembly consisted of two thin aluminum lead-ins placed on each side of a fiber strip and connected to each other by means of a platinum-iridium bridge. One lead-in was in contact with the primer plug, the other with an igniter retainer. The bridge and the fiber assembly were encased with a small quantity of lead styphnate coated with a green colored nitrocellulose lacquer and around this was placed a loose black powder charge.

When the firing circuit was closed the current passed from the insulated primer plug, up one of the lead-ins, through the wire bridge, and down the other lead-in, to the igniter retainer which grounded the current. The passage of the current heated the bridge sufficiently to ignite the lead styphnate surrounding it and this in turn ignited the black powder.

B. Percussion primers existed in the following types: C/12nA, C/12nASt (Steel), C/13nA, C/33 and M/33. All these types, as well as the Russian Primer 42/M used by the Germans, are described in TM 9-1985-3 (1953), pp 354-58

The C/12nA Percussion Primer consisted of a primer body threaded on the outside and recessed in the center to receive a brass anvil plug. The plug had a central flash channel and was recessed at the rearward end to form an anvil and to hold a brass primer

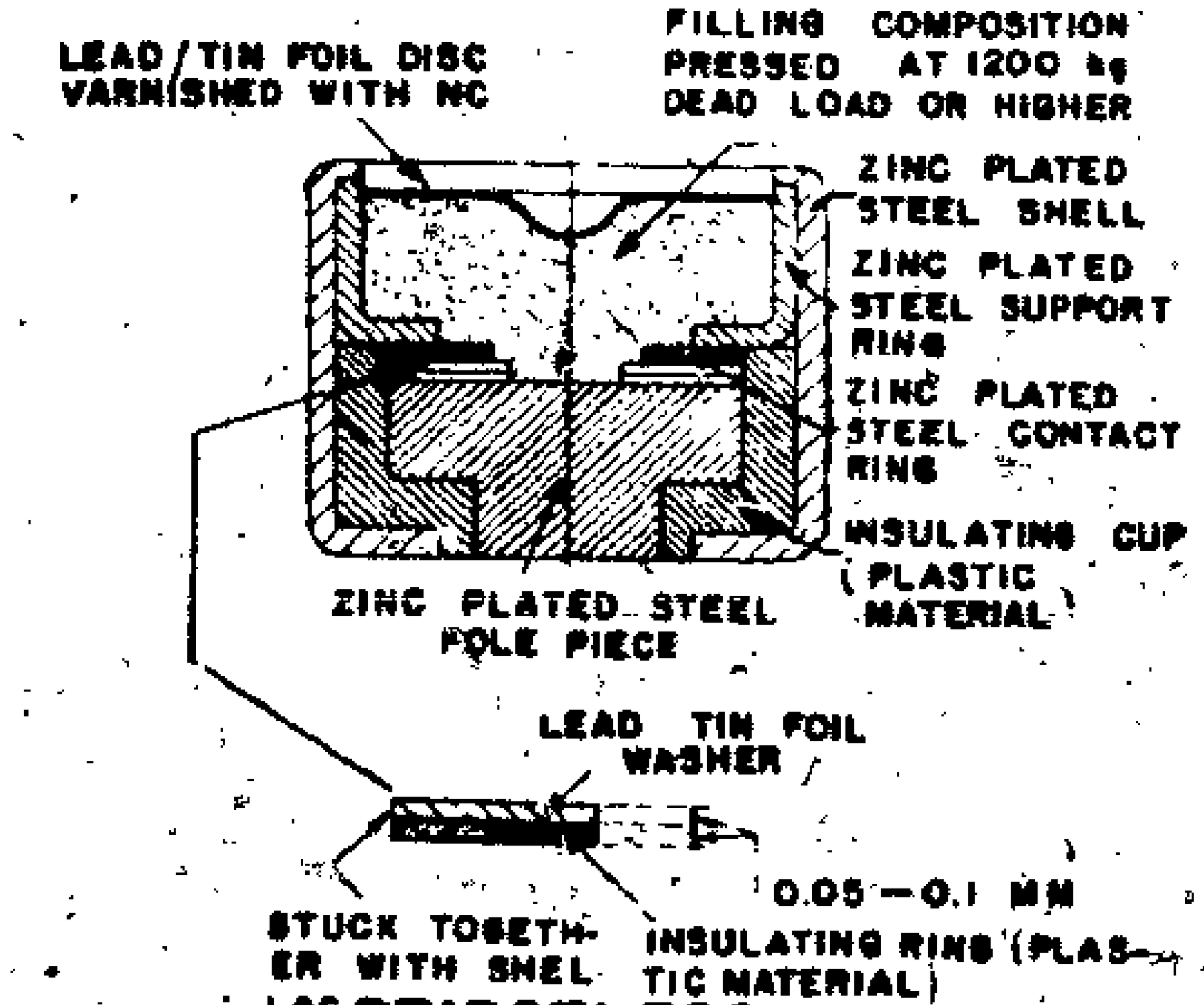


C/12nA PERCUSSION PRIMER

cup containing the primer mixture. The cup held the mixture against the anvil. Directly above the plug was placed a small amount of granular black powder with a black-powder pellet covering it. The pellet was held in position by a brass washer crimped over a varnished fabric disc. When the firing pin hit the primer, the cap pushed the primer mixture against the anvil, thus causing the mixture to ignite. The flash from the mixture went through the channel toward the black powder charges and ignited them and these in turn fired the propelling charge. This primer was used in ammunition for field guns and howitzers from 7.5 cm to 21 cm (excluding the 7.5 cm StuG) and also for the 5 cm Pak and the 8.8 cm Flak 18 and 36.

(See also Primary and Initiating Compositions).

Primer, Electric, Bridgeless Type was developed by the Deutsche Waffen- und Munitionsfabriken A-G, Lübeck. It consisted of a cylindrical casing (zinc plated steel) containing a primer mixture (presumably lead dinitrocresylate and azide), a pole piece, insulating cup, lead/tin foil washer (attached by shellac to an insulating material washer) and a contact ring. A current of 120-160 volts was required to fire the primer.
Reference: H.Peploe, CIOS Rept 33-20 (1945), pp 75 & 77.



BRIDGELESS TYPE ELECTRIC CAP

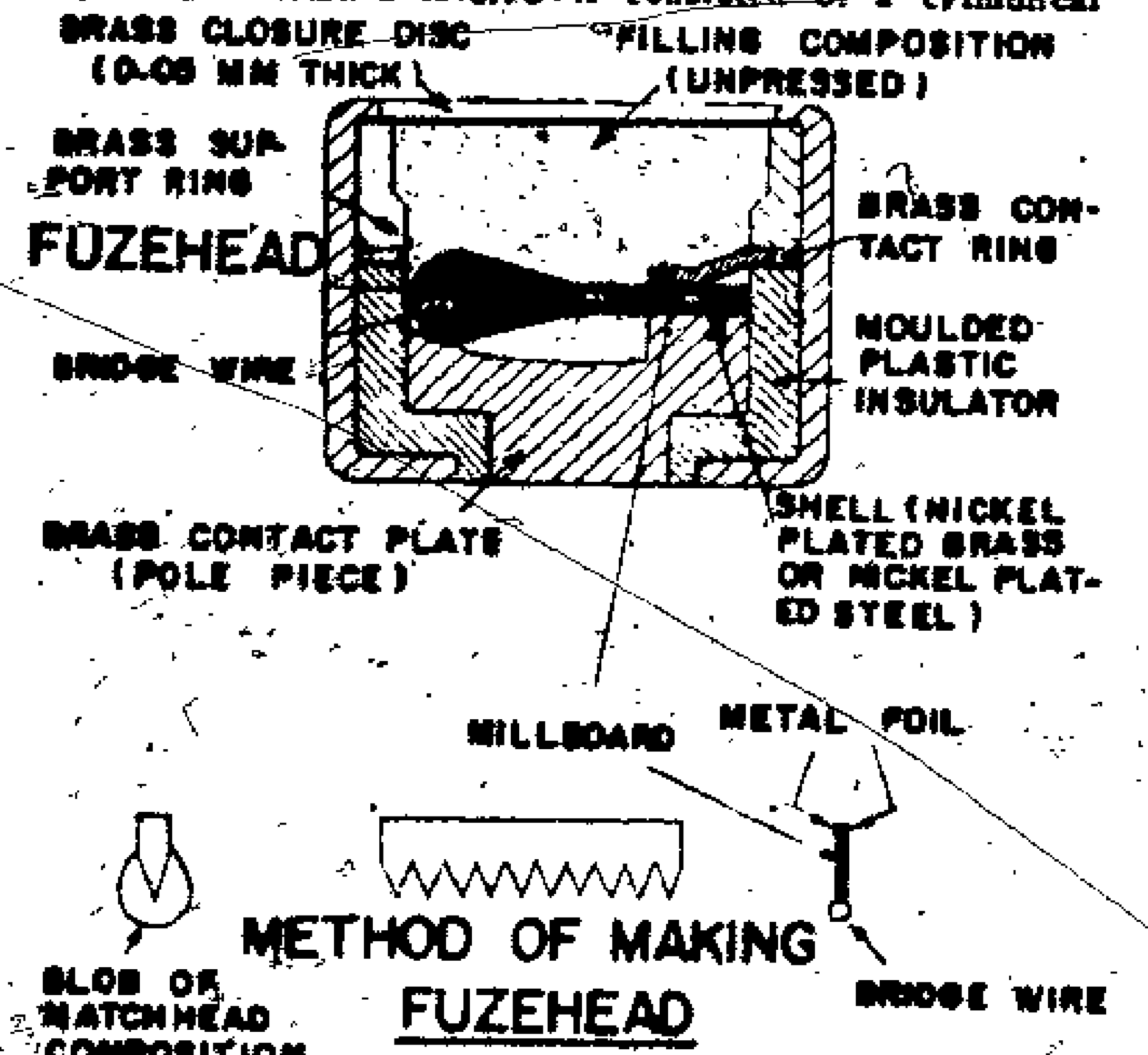
Primer, Electric, Bridge Type was developed by the Deutsche Waffen- und Munitionsfabriken A G, Lübeck and manufactured by the Rheinmetall-Borsig A G. It consisted of a cylindrical casing (nickel plated brass or nickel plated steel) containing essentially the following items:

a) A bridge wire soldered to two metal foil strips separated by a millboard (insulator). The bridge wire was coated by successive dips in a paste formed by mixing an igniter compound (such as lead styphnate or lead picrate) suspended in a NC varnish? (See under Fusehead)

b) A filling composition: K perchlorate 47, Pb styphnate 23 and Ca silicide 30%, loaded loosely around the fusehead.

Ammunition with electric primers were used mostly for synchronized aircraft guns, such as Mausers: 15 mm MG 151, 20 mm MG 151/200 and 20 mm MG 213. The bridge-wire primer existed in two types: C/25 and C/27, each requiring a firing current of 24 volts.

In addition to their use for synchronized guns, electric primers were used in some Turret guns and in AA guns.
Reference: H.Peploe et al, CIOS Rept 33-20 (1945), pp 73-6.



BRIDGE TYPE ELECTRIC CAP

Priming Compositions Used for Tracers. See under Tracers.

Progressive Rifling or Increasing System of Twist (Zunehmender Drall oder Wachsender Drall) is briefly described in the general section under Rifling.

Following German weapons used progressive rifling:

a) 75 mm KwK (6° to 9° twist)
b) 75 mm KwK 40, L/43 (6° to 9°)
c) 75 mm StuK 40; L/43 (6° to 9°)
d) 88 mm KwK (4° to 6°)
e) 88 mm Flak, Modifications 36 & 37 (4° to 6°)
f) 100 mm K 18 (4½° to 6°)
g) 105 mm Howitzer (6° to 12°)
h) 150 mm Howitzer (5° to 10°)
i) 150 mm K 39 (4° 17' to 5° 59')
j) 170 mm Gun (4° 16' 40" to 5° 58' 42")
k) 210 mm M 18 (5° 2' 45" to 5° 58' 42")
l) 210 mm K 38 (4° 29' 27" to 5° 30')
m) 240 mm Gun (3° 35' 43" to 7° 9' 25").

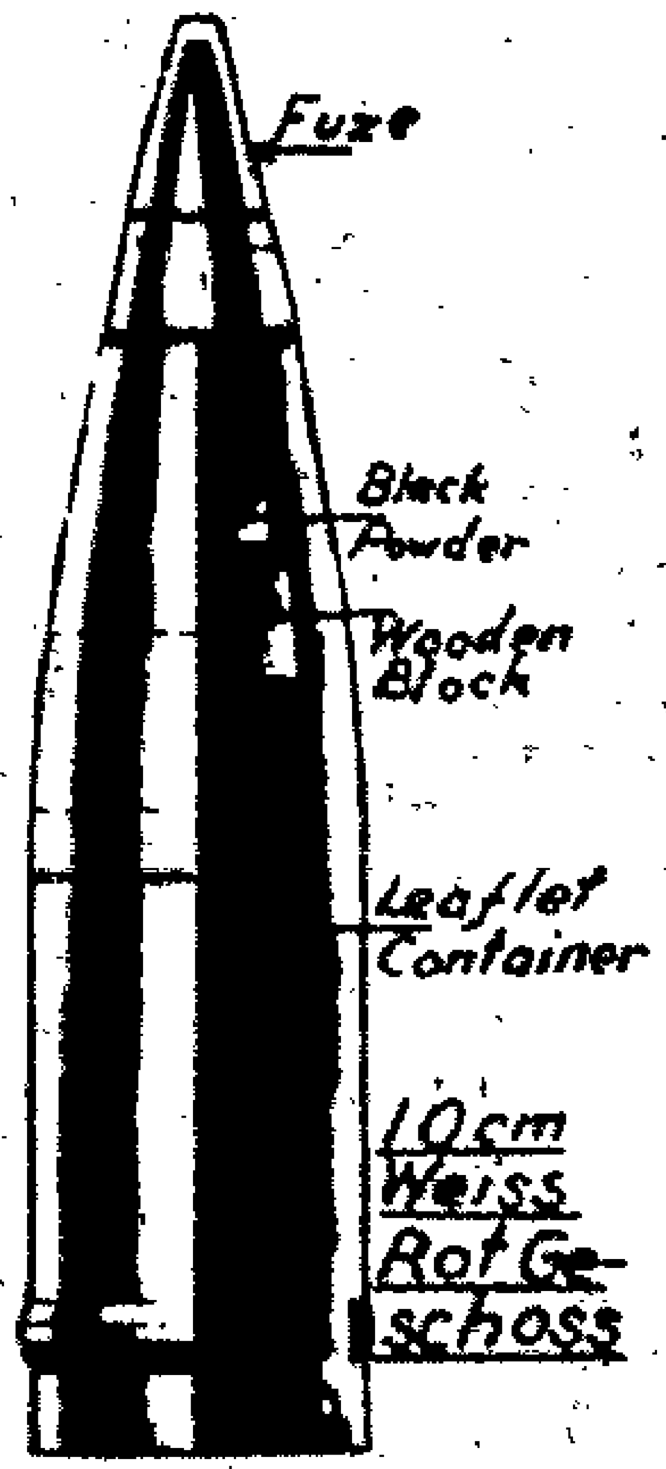
Reference:
R.P.Baumann of Picatinny Arsenal, Dover, N J, private communication.

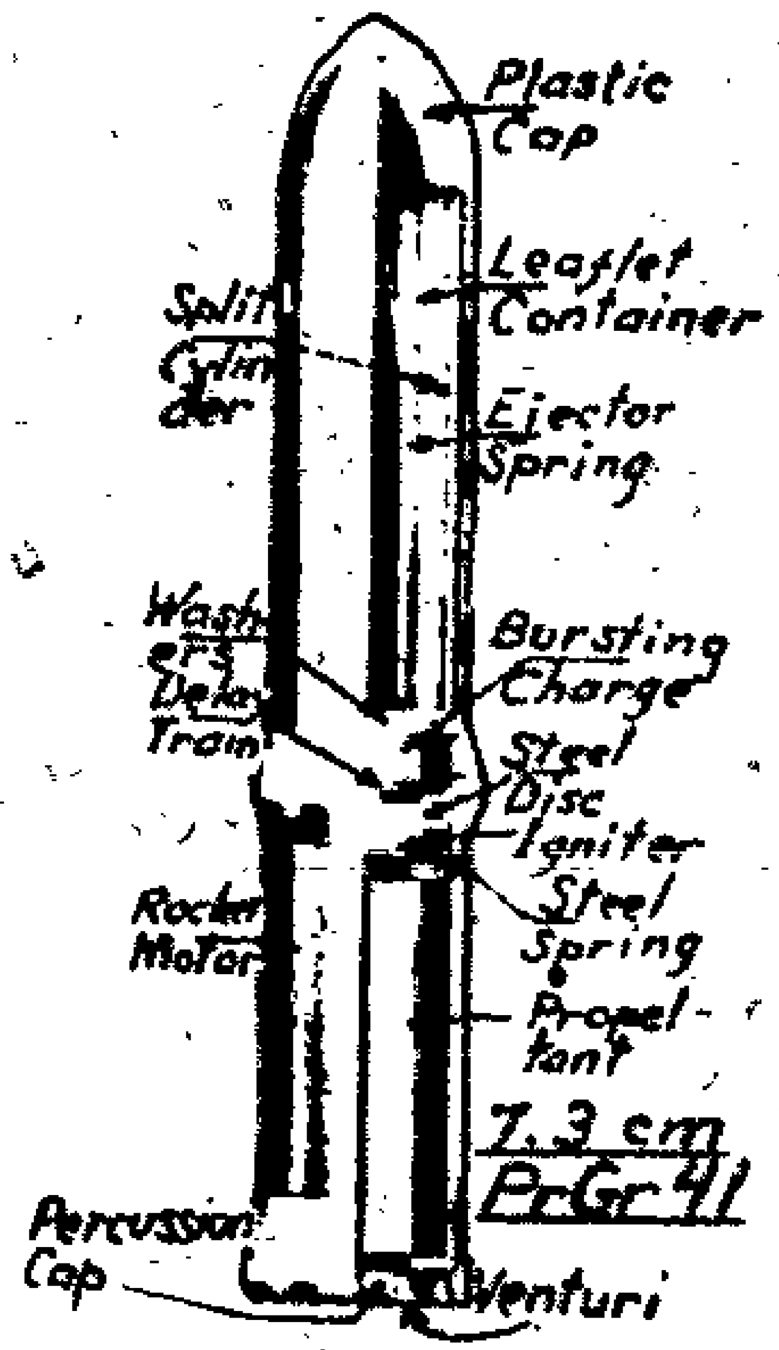
Projectile. See Granate.

Projectile, Flare. See under Flare.

Propagandagranate (Leaflet Projectile): One such projectile (caliber 105 mm), designated as 10 cm Weiss-Rot Geschoss, is described in TM 9-1985-3 (1953), p 462. It contained 28½ lb of leaflets and a small charge of black powder serving as a burster. The shell was fired from light field howitzers such as lFH 18, 18/1, 18/2, 18mM, 18/39 and 18/40 (See drawing next page).

Propagandarakete 41 (Leaflet Rocket), caliber 73 mm, consisted of two steel tubes screwed into a central joint. The lower part contained the rocket motor with propellant consisting of a cylindrical stick with nine longitudinal perforations—one in the center and eight in a circle around the central hole. Below this were 12 venturi set in two concentric rings. The upper section of the missile contained an inner cylinder (which was split longitudinally) with leaflets wrapped around a steel spring which was kept under compression. The missile was spin-stabilized and was fired from a single-tube launcher called the Propagandawerfer. The propellant was ignited by means of the percussion cap and when the rocket reached its destination, the igniter (located between the propellant and leaflets) fired the bursting charge. The resulting gas pressure ejected the inner cylinder and the plastic cap. As the split cylinder emerged, it fell apart and allowed the compressed spring to scatter the leaflets packed around it.
Reference: TM 9-1985-2 (1953), pp 234-5.
(See drawing on next page).





PROPELLANT, SMOKELESS POWDER (Treibmittel, Treibpulver oder Rauchlose Pulver). A general description of German propellants is given in Refs 1, 2, 3 and 4 listed at the end of this section.

Propellants used by Germans during WW I were described by H.Muraour, Mém Artil Fr, 2, 507 (1923) and by J.Pepin Lehalleur, Poudres etc, Baillière, Paris (1935), pp 290-291. They included the following propellants:

A) S (Rifle): NC (12%N) 24, NC (13%N) 72.5, DPhA 0.5, Cent 0.5, Am oxalate 0.7, gelatinizer (residual solvent) 0.5, and moisture 1.3%

B) Tube (Cannon): NC (12%N) 21, NC (13%N) 70, Cent or Acar 5, K bitartrate 2, residual solvent 0.7, and moisture 1.3%

C) Würfelpulver (Flaked propellant) (Rifle): NC (12%N) 60, NG 38.5, Cent or Acar 1 and moisture 0.5%

D) Würfelpulver (Cannon): a) NC (12%N) 29, NC (13%N) 29, NG 40, Cent 1, and moisture 1%; b) NC (12%N) 31, NC (13%N) 31 NG 30, Cent 7 and moisture 1%; c) NC (12%N) 30, NC (13%N) 31 NG 20, TNT 14.5, DNT 3.5, Cent 0.3, and moisture 0.7%

E) Röhrenpulver (Tubular propellant) (Cannon): NC (12%N) 32-34, NC (13%N) 32-34, NG 25-29, Cent 4-7, Am oxalate 0.5, Na carbonate 0.5, graphite 0.5 and moisture 0.9%.

Table 41 lists some propellants of WW I described in Ref 2, pp 134-6

Table 41
WW I Propellants

Composition %	For Small Arms: Strip	For Small Arms: Cube	For Ordnance: Tubular			For Ordnance: Cube		
NC (soluble)	24.0	60.0	21.0	-	32-34	29.0	31.0	30.0
NC (insoluble)	72.5	-	70.0	66.0	32-34	29.0	31.0	31.0
NG	-	38.5	-	-	25-29	40.0	30.0	20.0
TNT	-	-	-	25.0	-	-	-	14.5
DNT	-	-	-	5.5	-	-	-	3.5
Centralite	0.5 (or camphor)	1.0 (or acardite)	5.0	0.5	4-7 (or urethane)	1.0	7.0	0.3
Diphenylamine	0.5	-	-	-	-	-	-	
K tartrate	-	-	2.0	2.0	-	-	-	-
Na oxalate	0.7	-	-	-	-	-	-	-
Am oxalate	-	-	-	-	0.5	-	-	-
Na bicarbonate	-	-	-	-	0.5	-	-	-
Graphite	-	-	-	-	0.1	-	-	-
Moisture	1.3	0.5	1.3	1.0	0.9	1.0	1.0	0.7
Volatile solvent	0.5	-	0.7	-	-	-	-	-

Note: The Am oxalate was added to diminish the danger of ignition during rolling. Abbreviations: See under Table 44.

Propellants of WW II

The information contained below was derived from results of analyses of captured German propellants conducted at Picatinny Arsenal, Dover, New Jersey (mostly by P.R.Hosken, Jr.and H.Jadowitz of the General Laboratory) and also from documentary materials gathered by various American and British missions sent to Germany directly after termination of the War. (See Refs 4 and 10).

Following is a general survey of propellants used during WW II:

a) Both single and double-base propellants were used by the Germans during WW II. In double-base propellants it was the tendency to replace NG by DEGDN. This was partly due to the excessive erosion caused by NG propellants and partly because of the shortage of glycerin while DEG could easily be prepd synthetically from acetylene. Also, DEGDN is a better gelatinizer for NC than NG and for this reason smaller amounts of DEGDN could be used. The DEGDN propellants possessed much lower calorific values than NG propellants but they were not suitable for use in tropical climates on account of the high vapor pressure (and consequently high volatility) of DEGDN (see also "G" Pulver). Still cooler propellants, which were also less erosive and practically free from muzzle-flash were obtained when large amounts of nitroguanidine (NGu) were incorporated, as for instance, in the composition: NGu 30, NC 43, DEGDN 20, stabilizers and plasticizers 7% (see also Gudolpulver)

b) As flash reducers the Germans used salts of potassium such as sulfate, chloride, nitrate and oxalate. They were frequently supplied in bags for use only at night as they produced smoke which was visible in the day time. (See Vorlage) In propellants contg NGu there was no necessity to use the above salts because NGu acts as a flash reducer

c) Some German propellants contained between 1.5 and 3.0% of hydrocellulose, presumably to improve the burning characteristics, or to reduce flash

d) An interesting feature of German propellants of low calorific value was the use of mixed gelatinizers-stabilizers, such as centralites, acardites and urethanes. It was claimed that these mixtures had a better effect on the working properties and stability than when used individually

e) Of the other ingredients, magnesium oxide was included as a lubricant to facilitate rolling and extruding operations, graphite was added to reduce the formation of static electricity during manufacture, and the inclusion of about 3% alpha-MNN resulted in reducing the charge of low calorific propellants as much as 10%

f) It seems that there were no restrictions regarding the composition of the propellants provided the ballistic properties and stabilities complied with specifications. The composition of propellants manufactured at different plants but intended for use in the same type and caliber of gun were not the same, although they all passed inspection tests.

Table 42 gives compositions of some single-base (nitrocellulose) propellants examined at Picatinny Arsenal.

(See next page).

Remarks on Table 42

The propellants listed in Table 42 contained a number of features which are worth noting, such as:

a) None of these propellants contained a sufficient amount of non-volatile plasticizer to colloid the NC as effectively as is generally required. It is assumed that a volatile solvent was used in their manufacture which was later removed by drying. The amount of centralite present in some of these propellants would not be sufficient to gelatinize the high-nitrogen NC that was used in them but would be sufficient as a stabilizer

b) Since an insufficient amount of centralite was present for the complete gelatinization of the NC, it is presumed that camphor was used in some propellants to superficially gelatinize the surface of the grains. Thus, it would act as a deterrent and cause the propellant to burn more progressively

c) Several propellants were not only coated with graphite, but some of the graphite was incorporated in the grains. Coating with graphite was usually done for the following purposes: to decrease the possibility of ignition by static electricity, to make the grains more "free flowing" while loading the cartridge cases and to decrease (slightly) the initial rate of burning. Incorporation of graphite in the grains was apparently done to improve the burning characteristics of the propellant

d) When graphite was used for coating only, it is probable that the grains were previously given a surface treatment with centralite or other stabilizer-gelatinizer as a deterrent coating to make the propellant more progressive burning

e) Potassium salts (such as K sulfate) found in some German propellants, were evidently used as flash reducers. In some cases, however, markings on the bags included the abbreviation Man Pulv which stands for Manover Pulver Note: These were usually rapid-burning propellants because they were porous. The porosity was obtained by incorporation and subsequent elimination of most of the potassium salt by leaching with water

f) Some of the propellants examined at Picatinny Arsenal contained DPhA as well as DBuPh. As none of the German pre-WW II single-base propellants contained DPhA, it was presumed that these samples were reworked captured French or Belgian propellants

g) One of the samples examined at the Arsenal contained a large amount of PETN (63.8%) dispersed through the mass of NC. None of the Allied propellants had such composition.

One of the single-base (nitrocellulose) propellants used during WW II was prepd by gelatinizing a blend of two nitrocelluloses one of N content less than 12.5% and another of N content more than 13%. The gelatinizer used was an alcohol-acetone solution. [See Nitrochemie Industrieanlagen A-G, Ger P 715,811 (1941), C A 38, 2211 (1944)].

In Ref 4, p 41 is described Nitrocellulose-Blättchenpulver (Nitrocellulose Flake Propellant) which was prepd by thoroughly mixing in the presence of ether-alcohol 3 parts guncotton (Schiesswolle) of at least 13.1% N content, 1 part of soluble NC (Kollodiumwolle) of at least 12.6% content with 0.5% of stabilizer (such as diphenylamine) and 1% of flash reducer (such as Na oxalate). After the mass was flaked, the surface of the grains was treated with centralite and finely pulverized graphite. The flakes were about 0.3 mm thick and their surface was 1.3 mm^2.

Table 42

Single Base (Nitrocellulose) Propellants of WW II

Form	Composition, %							Uses
	NC	%N in NC	DPhA	Cent	Acar	Graph	Other Ingredients	
Square	95.1	13.2	-	-	1.8	-	Unac 3.1	7.63 mm Mauser
Square	95.2	13.0	-	-	0.3	0.2	Unac 4.3	7.92 mm AP
SP	34.3	12.2	-	0.2	-	0.3	PETN 63.8 Unac 1.4	7.92 mm AP
Square	95.1	13.1	-	-	1.0	1.0	Unac 2.9	7.92 mm AP
Square	95.0	13.2	-	-	-	-	Et carbamate & K sulfate 5.0	7.92 mm Ball, 7.92 mm Semi-AP, 7.92 mm AP and 7.92 mm HE
SP	32	12.5	-	0.4	-	0.6	PETN 60.0 Unac 7.0	7.92 mm HVAP
Square	98.4	13.1	0.9	-	-	-	Unac 0.7	7.92 mm Rifle Grenade A/T
-	99.5	13.0	0.5	-	-	Graphited	- -	7.92/13 mm AP
SP	56.0	13.2	-	Some	-		PETN 34.0 Cent & DNT 10.0	7.92 mm HVAP
Square	94.1	12.7	-	2.6	-	0.3	Unac 3.0	7.92 mm AP
SP	95.0	12.2	-	2.0	-	0.1	Unac 2.9	7.63 mm Mauser Pistol, 9.0 mm Pistol and 28/20 mm APHV
-	95.0	13.1	-	-	1.7	-	Unac 3.3	9.0 mm Pistol
-	97.4	13.0	-	-	0.5	-	Unac 2.1	9.0 mm Ball
SP	96.4	13.0	-	-	0.7	0.2	Unac 2.7	9.0 mm Ball, 9.0 mm Pistol and 50 mm Trench Mortar
SP	95.0	12.9	0.5	2.0	-	0.4	Unac 2.1	13.0 mm AP and 13.0 mm HE
SP	93.7	13.1	-	1.95	-	0.25	Camphor 0.95 Unac 3.15	20 mm AP
SP	94.7	13.1	0.3	-	-	0.3	DBuPh 0.1 Unac 4.6	20 mm HE Mauser
Square	95.7	13.2	0.3	3.4	-	0.5	K sulfate 0.3 Unac 1.8	20 mm HE Mauser
SP	93.5	13.1	-	2.8	0.6	1.5	K sulfate 1.1 Unac 0.5	20 mm Inc
SP	93.3	13.1	0.2	1.2	-	0.3	K sulfate 1.0 Unac 4.0	20 mm Solothurn
SP	94.1	13.0	0.4	2.4	-	0.4	Unac 2.7	13.0 mm AP, 13.0 mm HE, 15.0 mm HE and 28/20 mm APHV
SP	94.1	13.1	2.3	-	—	0.6	Camphor 1.0 Unac 3.0	20 mm APHV, 20 mm AP, 20 mm HE and 20 mm Inc
Tube	98.1	13.1	-	-	0.02	-	Unac 1.88	50 mm Trench Mortar
SP	94.5	13.1	-	-	-	0.8	Camphor 1.3 Unac 3.4	75 mm APC and 75 mm HE
SP	96.1	13.1	-	-	0.5	-	Unac 3.4	75 mm HE
Square	93.9	13.0	0.3	2.6	-	1.0	Unac 2.2	80 mm Expulsion Powder
Square	98.4	13.1	0.9	-	-	-	Unac 0.7	7.92 mm Rifle Grenade (A/T)

Abbreviations: See under Table 44.

Compositions listed in Table 43 are for double-base (NC-NG) propellants analyzed at Picatinny Arsenal during WW II.

(See next page).

Table 43

Double-Base (NC-NG) Propellants

Form	Composition, %							Uses
	NC	%N in NC	NG	Cent	Acar	Graph	Other Ingredients	
Tube	58.1	12.5	37.2	3.9	-	- -	K sulfate 0.3 Unac 0.5	37 mm APHV
Tube	69.7	11.9	27.3	1.5	0.2	- -	K sulfate 0.6 Unac 0.7	37 mm APMB
SP	63.7	11.8	28.5	6.3	-	0.1(incorporated)	Unac 1.5	37 mm HoC
Strip	64.0	12.3	30.0	6.0	-	- -	-	37 mm Czech
Strip	64.0	12.3	30.0	6.0	-	- -	-	40 mm Czech
Strip	63.0	12.2	28.0	9.0	-	- -	-	47 mm AP
Strip	63.1	12.4	30.3	6.0	-	- -	K sulfate 0.3 Unac 0.3	47 mm HE
Strip	62.9	12.2	29.1	7.3	-	- -	K sulfate 0.3 Unac 0.4	47 mm APCHE and APRN
Tube	61.1	12.0	22.4	12.7	-	- -	DNT 0.9 Vaseline 1.5 K salts 1.4	50 mm APC
Disc	59.6	12.9	39.0	-	0.7	0.1	Unac 0.6	75 mm HE How
Disc	59.5	13.0	38.7	-	0.8	0.2(incorporated	Unac 0.8	75 mm HoC (Semi-fixed)
Square	59.5	12.2	38.6	1.6	-	0.3	-	80 mm HE Mortar
Disc	59.2	13.0	38.5	-	0.6	0.3	Unac 1.4	80 mm HE Mortar
Disc	61.5	12.9	38.1	-	-	-	DPhUret 0.4	80 mm CM
Square	58.3	13.1	39.0	0.8	-	0.2	Unac 1.7	80 mm HE
Square	59.6	13.0	38.8	-	0.8	-	DNT 0.4 Unac 0.4	105 mm How
Square	59.4	12.9	31.4	-	8.9	-	Unac 0.3	105 mm How
Square	53.2	13.0	44.4	-	1.1	0.5	Unac 0.8	150 mm How (Base Charge)
Square	56.8	13.1	40.8	0.3	0.7	0.1	Unac 1.3	155 mm How and 80 mm HE
Square	59.0	13.1	39.0	-	1.0	-	Unac 1.0	155 mm How
Disc	56.5	13.3	41.6	-	0.8	0.2	Unac 0.9	Miscellaneous Mortars
Flake	59.9	13.36	39.0	0.9	-	0.2	-	80 mm Mortar
Square	62.5	12.0	33.0	-	0.2	0.1	DPhUret 1.5 EtPhUret 1.5 Unac 1.2	150 mm Rocket

Abbreviations: See under Table 44

Remarks on Table 43:

The double-base nitrocellulose-nitroglycerin propellants listed in Table 43 were somewhat different from the American and British propellants, as can be seen from the following remarks:

a) In cases in which large amounts of centralite were present, it served not only as a stabilizer, but also as a plasticizer, especially for low-nitrated NC. The amount of NG in such propellants was correspondingly decreased. In other cases where the amount of centralite was small, or even absent, the amount of NG was increased

b) It has been shown that when centralite is used in large amounts, it also acts as a flash reducing agent. The same applies to acardite (asymmetrical diphenylurea). When acardite was used as a stabilizer, an amount as low as 0.8% was sufficient

c) Vaseline, present in some propellants, was supposed to act primarily as a cooling agent (to lower the temperature of combustion and to reduce erosion). It also acted as a stabilizer to a certain extent because the unsaturated hydrocarbons present in vaseline combine with the oxides of nitrogen and thus stabilize the powder. It has been found, however, that vaseline is not particularly effective in reducing hygroscopicity

d) Graphite was used for coating some propellants (see Remarks (c) and (d) to Table 42, but in propellants of large grain size, such as the 155 mm, 150 mm and 120/45mm weapons, no graphite coating was used

e) As in some other German propellants, graphite was used not only as a coating agent but it was also distributed throughout the mass of material. [See Remark (c) on Table 42].

Table 44 gives compositions of some double-base propellants based on DEGDN (diethyleneglycoldinitrate) and on triple-base (NC-DEGDN-NGu) propellants.

(See next page).

Table 44

Double-Base (NC-DEGDN) and Triple-Base (NC-DEGDN-NGu) Propellants

Form	Composition, %								Uses
	NC	%N in NC	DEGDN	Cent	Acar	Graph	Other Ingredients		
Tube	66.1	11.9	30.2	1.8	0.2	-	Unac	1.7	37 mm AP Shell
Tube	63.3	12.1	31.5	2.7	-	0.3	K sulfate	0.4	37 mm HE
Tube	66.3	11.8	29.4	2.7	-	0.2	Unac	1.4	47 mm APHV
Tube	61.4	11.8	29.8	8.4	-	-	Unac	0.4	50 mm AP
Tube	61.5	12.0	26.0	7.4	-	0.3	Vaseline K salts Unac	3.5 0.5 0.8	
Tube	68.7	11.8	28.4	1.5	0.1	-	K salts Unac	0.4 0.9	50 mm APHV
Square	58.4	12.6	32.0	-	-	0.3 (incorporated)	NGu K sulfate (added)	29.3 2.7	50 mm HE
Tube	60.0	13.1	38.4	-	0.7	0.1	Unac	0.8	50 mm HE
Tube	97.1	12.9	0.9	0.1	-	0.3	Unac	1.6	50 mm TM
Tube	63.1	12.4	32.7	0.5	0.7	-	Unac	1.0	50 mm APHV
Tube	66.4	11.8	29.8	2.2	-	0.2	K sulfate Unac	0.5 0.9	50 mm APHV, 47 mm APHV, 37 mm HE and 37 mm AP
-	57.6	12.2	29.8	-	-	0.1	NGu Unac	31.4 1.1	42/28 mm Tapered Bore and 42/28 mm APHV
Tube	65.0	11.9	23.2	8.8	-	0.1	K sulfate Unac	1.5 1.4	75 mm AP
Tube	39.0	12.5	30.5	-	-	0.1	NGu Unac	28.9 1.5	75 mm HE
Tube	62.3	13.0	34.4	-	0.4	0.1	K sulfate Unac	2.5 0.3	75 mm HE
Strip	63.5	12.4	33.9	1.4	0.4	0.1	Unac	0.7	75 mm HoC, Semi-Fixed
Strip	59.6	12.8	38.6	-	-	0.2	EtPhUret Unac	1.2 0.4	75 mm HoC, Semi-Fixed
Tube	60.3	11.9	28.2	7.3	-	0.4 (incorporated)	Vaseline K sulfate Unac	2.0 1.1 0.7	75 mm Tank Gun
Square	38.4	12.4	31.5	-	-	0.2 (incorporated)	NGu Unac	29.0 0.9	75 mm HEHoC, 75 mm HE Pak 40 and 50 mm HE
Square	62.0	12.4	26.0	7.6	0.2	0.2	EtPhUret Unac	3.1 0.9	76.2 mm AP
Note:	76.2 mm and some 88 mm weapons were those captured in Russia								
Flake	58.6	12.2	30.9	-	-	0.3	NGu	30.2	76.2 mm HE
Tube	67.2	11.8	28.2	3.3	-	-	Unac	1.3	88 mm AP
Tube	43.0	11.0	18.5	-	0.2	-	NGu DPhUret EtPhUret Unac	31.2 3.2 2.2 1.7	88 mm AP
Tube	66.7	11.8	28.2	3.3	-	-	Unac	1.8	88 mm HE
Square	61.6	13.1	37.3	0.3	0.4	0.1	Unac	0.3	150 mm How (Zones 1-6)
Square	62.1	13.0	36.6	0.4	0.3	0.1	Unac	0.5	150 mm How (Zone 7)
Disc	59.6	13.0	38.7	0.4	0.5	0.2	Unac	0.6	150 mm How (Zones 7&8)
Tube	59.6	12.6	33.6	-	-	0.2	DPhUret EtPhUret Unac	1.5 3.0 2.1	75 mm Rocket
Tube	61.1	-	33.3	-	2.1	0.2	Unac	3.3	150 mm Rocket
Tube	59.6	12.5	34.8	-	0.2	0.2	EtPhUret DPhUret Carnauba wax Unac	1.2 2.0 0.3 1.7	210 mm Rocket
Tube	60.0	-	35.4	-	-	-	Unac	4.6	300 mm Rocket

(See also G Pulver and Gudolpulver).

Abbreviations: AA Antiaircraft; AC Aircraft; Acar Acardite; Am Ammonium; AP Armor-piercing; A/P Antipersonnel; APC Armor-piercing, Capped; A/T Antitank; Cent Centralite; CM Chemical Mortar; DBuPh Dibutylphthalate; DEG Diethyleneglycol; DEGDN Diethyleneglycol Dinitrate; DNT Dinitrotoluene; DPhA Diphenylamine; DPhUret Diphenylurethane; Et Ethyl; EtPhUret Ethylphenylurethane; Flak Ger designation for AA; Graph Graphite; HE High Explosive; HoC Hollow Charge, shaped charge; HV Hyper-Velocity; Hydrocel Hydrocellulose; Inc Incendiary; K (Kannone) Cannon; K salts Potassium salts; LC Long Case; MB Monoblock; MNT Mononitrotoluene; N Nitrogen; NC Nitrocellulose; NG Nitroglycerin; NGu Nitroguanidine; Pak German designation of A/T; PETN Pentaerythritol Tetranitrate; RN Round Nose; SC Short Case; SP Single Perforation; T Tracer; TEG Triethyleneglycol; TEGDN Triethyleneglycol Dinitrate; TM Trench Mortar; TNT Trinitrotoluene; Unac Unaccounted.

Remarks on Table 44 (See previous page).

Although the above DEGDN and NGu plus DEGDN propellants were similar in composition to NG propellants listed in Table 43, they had some features which are worth noting, such as:

a) There was a definite relationship between the percentage of NC and DEGDN used, as the percentage of NC was decreased the amount of DEGDN (which has about the same potential as NG) was increased. It was also noted that decreasing amounts of centralite were accompanied by increasing amounts of DEGDN

b) The use of low nitrogen content NC, such as 11.8-12%, in DEGDN propellants may be explained by the fact that high N content NC is much more difficult to gelatinize with DEGDN

c) Several propellants contained about 30% NGu and only about 40% of NC, without any stabilizer. In most of these compositions graphite did not serve for coating but was uniformely distributed throughout the grains. It is to be noted that NGu does not gelatinize NC even of low N content.

d) All the DEGDN propellants, especially those containing NGu were much cooler burning than the corresponding NG propellants

e) From the *American* point of view the DEGDN propellants have the following disadvantages over propellants based on NG:

1) They are more volatile
2) Less sensitive to flame and thus more difficult to ignite
3) More toxic to personnel handling them
4) They contain an ingredient (DEGDN) which is more difficult to stabilize than NG.

H. Muraour et al, Mém poud 35, 280 (1953), gives the composition of a German propellant, used in rounds for 50 mm airplane cannon, as follows: NC (N content 11.81%) 63.5, DEGDN 26.5, centralite 8.0 and vaseline 2.0%.

Some information on DEGDN-NC propellants prepared at the Düneberg Fabrik, D A-G may be found in Ref 7. Two of these propellants used in cannons are listed in Table 45a.

(See next column).

The same Ref 7 gives the composition and properties of the DEGDN propellant manufd by the Wolff Co Plant at Bömlitz, near Walsrode: NC (N content 12.15%) 28.6, DEGDN 17.4, DPhA 0.5, Cent I 0.5 and TNT 53.0%. Oxygen balance -16.51% and calorific value 750 kcal/kg.

Some double-base (NC-DEGDN) and triple-base (NC-DEGDN-NGu) propellants manufactured at the Düneberg Fabrik, Dynamit A-G were described in Ref 5. Their composition is given in Table 45b.

(See next page).

Table 45a

NC-DEGDN Propellants of Düneberg Fabrik D A-G

Composition and properties	German Designation	
	S6702	B14232
NC	29.45	48.59
% N in NC	12.0	12.5
DEGDN	29.45	26.16
Am nitrate	40.00	-
Dicyandiamide	-	25.00
Centralite I	1.00	-
MNN	-	1.00
Mg oxide	-	0.15
Graphite	-	0.10
Moisture	1.10	0.80
Total	101.00	101.80
Oxygen Balance, %	+3.29	-22.47
Calorific Value, kcal/kg	1143	719

Abbreviations: (See under Table 44).

In Ref 6 is described the manuf of NC and propellants at the Krümmel Fabrik, Dynamit A-G. while in Ref 8 is described the manufacture of NC and propellants at the following plants: Troisdorf Fabrik D A-G, Ebenhausen Fabrik D A-G, Rottweil Fabrik D A-G and Bömlitz Fabrik of Wolff Co.

In the prepn of propellants at the Rottweil Plant the blend consisted of 20 parts NC, N content 12.5%, and 80 parts of NC, N content 13.3%.

Table 46 gives some properties, including the burning characteristics, of several German propellants examined at Picatinny Arsenal during WW II (Refs 4, 10a, 10f and 10g).

(See next page).

Remarks on Table 46:

a) In the compositions given in Table 46 only the main ingredients are included. Other components, such as stabilizers, graphite, etc were given in Tables 42, 43 & 44

b) Force of a Propellant (H×V) is a function of its chemical composition

c) Quickness (Δ) of a Propellant is a function of granulation as well as of its composition. The most important variables are total volatile content and web size. The quickness is approximately inversely proportional to the web size. In small arms propellants, the concentration gradient of the deterrent coating is used to alter the quickness

d) The relative quickness of propellants is obtained by comparing their burning rates with the rate of a standard. If comparison is made between a German propellant and a standard American propellant, the results are likely to be misleading since the German guns (made with a heavy breech) used propellants designed to develop the maximum pressure rapidly and after the shell had travelled only a

Table 45b

Double-Base (NC-DEGDN) and Triple Base (NC-DEGDN-NGu) Propellants of Düneberg Fabrik, DA-G

Form	Compositions, %									Calorific value kcal/kg	Uses
	NC	%N in NC	DEGDN	NGu	Cent	Acar	Graph	MgO	Other Ingredients		
Flake	63.65	13.0	35.80	-	-	0.50	-	0.05	- -	-	Various Hows
Flake	54.40	13.0	44.50	-	-	0.50	0.05	0.05	K sulfate 0.50	-	Various Hows
Flake	58.03	13.0	31.12	30.00	-	0.50	0.10	0.25	-	-	Various Hows
Tube	67.65	12.0	29.00	-	3.00	-	0.10	0.25	-	825	88 mm AA and Heavy 100 mm Gun (K18) (Army)
Tube	68.22	12.0	29.23	-	1.70	0.50	0.10	0.25		870	37 mm AA and 37 mm A/T(Army)
Tube	62.33	12.0	26.72	-	8.00	-	0.10	0.25	Vaseline 1.80 Phthalate 0.80	700	Heavy Army Field Hows
Tube	61.53	12.0	26.37	-	7.50	-	0.10	0.25	Vaseline 1.60 Phthalate 0.65 K sulfate 2.00	-	100 mm Army Gun (K 18)
Tube	64.08	12.0	27.47	-	5.35	-	0.10	0.25	Vaseline 1.85 Phthalate 0.90	730	88 mm Army AA Gun
Tube	43.51	12.0	18.64	30.00	-	0.50	0.10	0.25	DPhUret 3.25 EtPhUret 3.75	750	88 mm Army AA HE Gun
Tube	39.48	12.0	16.92	30.00	-	-	0.10	0.25	DPhUret 4.25 EtPhUret 5.00 K nitrate 4.00	730	88 mm Army AA and AP Guns
Tube	69.92	12.0	14.85	-	3.00	-	0.10	0.15	DNT 10.00 alpha-MNN 2.00	730	88 mm AA and other Army Guns
Tube	60.55	12.0	25.95	-	3.75	-	0.10	0.15	Hydrocell 3.00 DNT 4.00 alpha-MNN 2.50	730	Various Army Guns
Tube	44.00	12.0	18.85	20.00	-	0.40	0.10	0.15	DNT 3.50 alpha-MNN 2.00 DPhUret 1.50 EtPhUret 1.50 Hydrocel 4.00 K nitrate 4.00	720	Various Army Guns
Tube	69.38	12.2	25.27	-	5.00	-	0.10	0.25	- -	820	Naval Guns
Tube	63.55	12.2	23.87	-	9.00	-	0.10	0.25	Phthalate 1.25	730	Naval Guns
Tube	65.71	12.2	23.94	-	2.50	0.50	0.10	0.25	alpha-MNN 7.00	730	Naval Guns
Tube	58.55	12.2	-	-	12.00	-	0.10	0.25	TEGDN 25.10 K sulfate 4.00	650	Naval Guns
Tube	35.50	12.2	21.75	40.00	-	0.50	0.10	0.25	DPhUret 0.70 EtPhUret 0.70 K sulfate 0.50	820	37 mm Naval Gun
Tube	42.45	12.0	18.20	25.00	-	-	0.10	0.25	DPhUret 4.50 EtPhUret 4.50 K sulfate 5.00	730	Naval Guns
-	60.17	12.6	35.33	-	-	-	-	0.25	Hydrocel 1.50 DPhUret 1.00 EtPhUret 1.40 IG Wax E 0.35 K nitrate(added) 0.80	900	Universal composition for Rocket Launchers
-	59.03	12.6	34.82	-	-	0.50	-	0.25	Hydrocel 3.00 EtPhUret 1.90 Vaseline 0.50	865	300 mm Rocket Launcher

Abbreviations: See under Table 44.

Table 46

Properties of Some German Propellants

Form	Composition, %					Uses	Some Properties				Burning Characteristics		
	NC	%N in NC	NG	DEGDN	NGu		Web (in inches)	H	V	Force (HxV)	Δ	A	C
SP Tube	63.6	11.8	28.5	-	-	37 mm HEHoC	.0304	881.5	776	674,846	6.62	-	-
Cord	65.7	13.08	20.8	-	-	Antitank Gun	.0628	890	842	749,380	-	-	-
SP	59.6	12.5	-	38.8	-	Rocket	2.46	829.7	705.8	585,602	5.53	-	-
SP	63.0	11.9	-	26.5	-	100 mm K 18	.0337	740.1	907.4	597,556	5.08	-	-
SP	38.5	11.3	-	16.5	34.8	88 mm HELC	.0377	706.9	680.1	460,762	1.2	-	-
Square	36.0	12.0	-	31.0	32.2	76.2 mm A/T	.0209	877	777	681,429	-	-	-
SP	65.0	11.93	-	23.2	-	75 mm APCLC	.0600	712.1	722.3	512,349	4.21	-	-
Strip	63.5	12.4	-	33.9	-	75 mm HEHoC	.203	893.8	711.3	635,760	7.0	-	-
Square	39.4	12.9	-	30.9	28.9	75 mm HEHoC	.0249	910.6	706.2	643,066	7.26	-	-
Cylinder	59.6	12.55	-	33.6	-	75 mm Leaflet Rocket	.333	856.6	721.0	617,608	-	-	-
Square	40.0	12.4	-	30.3	28.7	75 mm HE Tank	.0261	901	767	691,067	-	-	-
SP	37.4	12.2	-	30.2	31.3	42/28 mm APHV	.0279	883.2	716.2	632,228	5.6	-	-
SP	94.8	12.8	-	-	-	28/20 mm APHV	.0237	829.7	705.8	585,602	0.94	-	-
SP	92.75	13.03	-	-	-	28/20 mm APHV	.0211	829.7	705.8	585,602	0.94	-	-
Square	53.15	13.0	44.4	-	-	150 mm How (Base Charge)	.0067	1235.1	588.6	727,333	9.9	.05	211
Square	61.64	13.1	-	37.3	-	150 mm How (1-6 zones)	.0484	1015.9	685.2	696,094	8.5	.017	167
Square	62.13	13.0	-	36.6	-	150 mm How (7 zone)	.0313	993.6	696.7	692,242	8.4	.009	144
SP Disc	59.6	13.0	-	38.7	-	150 mm How (7-8 zones)	.0722	989.4	704.5	697,037	9.8	.21	158

Abbreviations: A Constant called Vivacity; C Rate of evolution of hot gases at a pressure of 20,000 psi in liters at atmospheric pressure / sq cm of surface / second; H Heat of Combustion in kcal/kg; P Pressure of propellant gases in psi; V volume of gases liberated in l/kg; Δ Burning rate (quickness) of the propellant at 20,000 psi in inches/sec; (HxV) Force or Thermodynamic Potential.

Other abbreviations are given under Table 44.

short distance along the bore of the gun. On the other hand, in American guns with a lighter breech the propellants are designed to develop the maximum pressures more slowly and after the shell has travelled a greater distance along the bore of the gun

e) In the relation of quickness to composition, it may be noted that the single-base propellants are the slowest and are comparable to those double-base propellants which contain NGu. Propellants containing NG are usually the fastest, followed by DEGDN propellants. In some cases, however, DEGDN propellants are faster than those containing NG. This is usually the case when the NC in a DEGDN propellant is of considerably higher nitrogen content than that used in a corresponding NG propellant

f) The burning rate of the German 210 mm rocket propellant was given equal to: $-0.35+(29.4\times10^{-5}P)$ while the corresponding value for the standard American double-base 7/8" stick propellant is: $48.6\times10^{-5}P$. This means that the rate for the American propellant is about 65% greater than for the German propellant

g) Experimental procedures for the determination of the burning rates of propellants are described in Pic Arsn Tech Rept 1235 (1943)

h) Methods of computation of properties of propellants are given in the Du Pont, Burnside Laboratory Memorandum Report 31.

References (Propellants):

1) A.Marshall, Explosives, Churchill, London, v 1 (1917) v 2 (1917) and v 3 (1932)

2) H.Brunswig, Das rauchlose Pulver, W. de Gruyter Berlin (1926)

3) A.Stettbacher, Schiess- und Sprengstoffe, J.A.Barth, Leipzig (1933)

4) Collective, PB Rept 11,544 (1945)

5) O.W.Stickland et al, PB Rept 925 (1945)

6) L.Nutting et al, PB Rept 16,666 (1945)

7) F.J.Krieger, M.Plesset, PB Rept 7826 (1945)

8) R.Ashcroft et al, BIOS Final Report 833 (1946), Item 2

8a) H.H.MPike, CIOS Report 31-68 (1946), Report on Visit to Düneberg Factory of D A -G

9) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948)

10) Picatinny Arsenal Technical Reports:

a) Collective, 1282 (1943) (Foreign Propellants)

b) A.B.Schilling, 1358 (1944) (Propelling Charge for 155 mm Separate Loading Ammunition)

c) A.B.Schilling, 1439 (1944) (Separate-Loading Propelling Charge Assembly for 105 mm Recoilless Gun, LG 41)

d) J.P.Wardlaw, 1443 (1944) (Propelling Charge for Separate-Loading 100 mm Gun, K 18)

e) A.B.Schilling, 1453 (1944) (Propelling Charge for 210 mm Separate-Loading Ammunition)

f) Collective, 1456 (1944) (Foreign Propellants)

g) W.R.Tomlinson, Jr, 1555 (1945) (Chemical Composition of Material used in German Ammunition)

Propellents: Artillery. According to H.H.M.Pike, CIOS Report 31-68 (1946), pp 4-8 and tables, the following types of propellants were used by the Germans in their artillery weapons:

A. **Nitrocellulose (NC) Propellant**, designated as NzP (Nitrozellulose Pulver) was of the following varieties:

a) NzBlP (Nitrozellulose Blättchenpulver) was used in 105 mm light field howitzer

b) NzManNP (Nitrozellulose Manöver Nudelpulver) was used in blank (practice) ammo

c) NzRP (Nitrozellulose Röhrenpulver) was used in some 20 mm & 30 mm AA guns, 75 mm tank and self-propelled guns, 75 mm Navy gun C/34, 105 mm casemate and tower gun and 105 mm light field howitzer 18

B. **Nitroglycerin (NG) Propellant**, designated as NglP (Nitroglyzerin Pulver), was of the following varieties:

a) NglBlP (Nitroglyzerin Blättchenpulver) was used in 75 mm mountain gun 15 and 80 mm heavy mortar 34

b) NglPlP (Nitroglyzerin Plättchenpulver) was used in 75 mm infantry gun 18 and in 75 mm tank and self-propelled guns

c) NglRgP (Nitroglyzerin Ringpulver) was used in 80 mm heavy mortar 34

d) NglRP (Nitroglyzerin Röhrenpulver) was used in 75 mm Navy gun C/34, 75 mm mountain gun 15 and 88 mm torpedoboat gun

C. **Diethyleneglycol Dinitrate (DEGDN) Propellant**, designated as DiglP (Diglykol Pulver) was of the following varieties:

a) DiglBlP (Diglykol Blättchenpulver) was used in 50-mm casemate and tower gun, 105 mm light howitzer 18, 105 mm mountain howitzer, 150 mm heavy infantry gun 33, and 150 mm heavy howitzer 18

b) DiglLgP (Diglykol Leuchtgeschoss Pulver) was used for propelling star shells in 88 mm Navy guns C/30, C/32 & C/35, 105 mm Navy guns C/28, C/32 & C/33, 88 mm torpedoboat gun, 105 mm Navy guns C/28, C/32 & C/33, 128 mm Navy gun C/34, 149.1 mm U-boat gun L/45, 149.1 mm Navy guns C/25, C/28, L/45, & L/55, 172.6 mm Navy gun L/40, 203 mm Navy gun C/34a, and 209.3 mm Navy gun L/45

c) DiglPlP (Diglykol Plättchenpulver) was used in 75 mm field gun 18

d) DiglRgP (Diglykol Ringpulver) was used in 105 mm mountain howitzer, 150 mm heavy howitzer 18, and 210 mm mortar

e) DiglRP (Diglykol Röhrenpulver) was used in 37 mm AA guns, 37 mm A/T guns, 42/28 mm tapered-bore gun, 50 mm A/T guns, many 75 mm Army guns, and 88 mm 105 mm, 128 mm, 149.1mm Navy, 150 mm Army, 172.6 mm Navy, 203 mm Navy, 203 mm Navy, 209.3 mm Navy, 210 mm, 238 mm, 240 mm 283 mm Navy, 280 mm, 283 mm, 305 mm, 350 mm, 380 mm, and 420 mm weapons

f) DiglStrP (Diglykol Streifenpulver) was used in 42/28 mm tapered bore gun

D. **Triethyleneglycol Dinitrate (TEGDN) Propellant**, designated as TriglP (Triglykol Pulver), was used instead of DiglP in hot climates, because Diglykolnitrat (DEGDN) is very volatile. One such propellant TriglLgP (Triglykol Leuchtgeschoss Pulver) was used by the Navy in star shell ammo

E. **Nitroguanidine (NGu) Propellant**, designated GuP (Gudolpulver), existed in the following varieties:

a) GuBlP (Gudol Blättchenpulve) was used in 50 mm A/T gun, 105 mm mountain howitzer, 150 mm heavy infantry gun 33, 150 mm heavy howitzer 18 and 150 mm heavy howitzer for fortifications

b) GuRgP (Gudol Ringpulver) was used in 210 mm mortar 18

c) GuRP (Gudol Röhrenpulver) was used in 42/28 mm tapered-bore gun, 88 mm tank and A/T gun 43, 105 mm recoilless gun, 128 mm AA gun 40, 128 mm tank destroyer gun 44, 211 mm gun 12, 380 mm Siegfried gun, 406.4 mm Adolf gun, 533.4 mm gun called Gerät 36 and 800 mm Sevastopol gun

F. **Ammonium Nitrate (AmN) Propellant**, designated as Ammon P (Ammonpulver), was developed towards the end of WW II to combat shortages of some materials. The propellant AmmonStrP (Ammonstreifenpulver) was in the shape of strips, 500x20x2.3 mm, and its composition was: NC (12%N) 22, DEGDN 22, Am nitrate 50, hydrocellulose 5 and centralite 1%. The strips were coated with a regular DiglP in order to overcome the hygroscopicity

Table 47 gives composition and some properties of most common artillery propellants used during WW II by the Germans. (See following pages).

Propellants, Internal Ballistic Data is given in tables at the end of CIOS Report 31-68 (1946).

Propellants, Rocket. See Rocket Propellants.

Propellants, Stability of. The stability characteristics of some German propellants were determined during WW II at Picatinny Arsenal and described in Technical Report 1456 (1944).

In cases where sufficient material was available, both the 120° and 134.5° Heat Tests were made. The results of tests showed a tendency toward greater stability for those propellants which contained a stabilizer-gelatinizer (such as centralite) in combination with another stabilizer, such as acardite.

Sufficient amounts of propellants were not available for reaching a definite conclusion concerning the merits of disubstituted urethanes in combination with acardite.

Propellants containing NG, DEGDN and NGu-DEGDN proved to be of satisfactory stability, judging by the 120° Heat Test of the U S Army (the test paper should not turn a salmon pink color in less than 40 minutes).

As to the single-base propellants, only a few of the German propellants met the U S Army Specification which requires that the test paper in the 134.5° Heat Test shall not turn salmon pink in color in less than 45 minutes.

Propellant Charge in Fixed and Semi-Fixed Ammunition. According to E.Englesburg (The Ordnance Sergeant, May 1944, p 321), German propelling charges may be subdivided into two main classes:

a) Class No 1 (Fixed round) used flaked and tubular propellants. In this case, the grains were packed in a silk bag with an igniter bag sewed to the end facing the primer. With tubular grains, they could be either packed in a silk bag (as above) or tied in a bundle by means of a fine twine. The lower end of the bundle of tubes was placed in a short silk bag, which had sewn to its bottom, a coarser silk bag containing igniter composition

b) Class No 2 (Semi-fixed round) consisted of base and increment charges (zones) contained in silk bags. An igniter bag was sewn to the base charge. The charges were shipped inside the cartridge case and if there were too many increments for the desired range some or all increments but not the base charge could be removed (before firing) and substituted by the "distance piece" (q v). In case of long range firing a super charge, packed in a cardboard or metal container, was provided.

Some propellent charges had a bag with a flash reducing agent (which was placed between the propellant and projectile) while others had a decoppering agent such as lead wire wrapped around the bag.

Propellent Grains and Their Dimensions. The following typical German propellants are listed by H.H.M.Pike in CIOS Report 31-68 (1946), pp 4-5 and tables:

a) Tubular (Röhrenpulver), designated as RP 40 (810 x 13x4.3) consisted of tubes 810 mm long having external and internal diameters of 13 mm and 4.3 mm respectively.

b) Strip (Streifenpulver), designated as StrP (100 x 10 x 0.6), consisted of grains 100 mm long, 10 mm wide and 0.6 mm thick

c) Flake (Blättchenpulver), designated as BlP (3 x 3 x 0.8), consisted of grains 3 mm long, 3 mm wide and 0.8 mm thick

d) Disc (Plättchenpulver), designated as PlP (50 x 0.2), consisted of discs 50 mm in diameter and 0.2 mm thick

e) Ring or annular (Ringpulver), designated as RgP (0.2 x 50/10), consisted of grains 0.2 mm thick, 50 mm in diameter and a central hole of 10 mm in diam

TABLE 47
(Artillery Propellants)

TYPE	COMPOSITION, %									Calorific value kcal/kg		Temp of comb °K	Uses
	NC	%N	NG	DEGDN	NGu	Centr	MgO	Graph	Other ingredients	Exper	Theor		
NglBlP 12.5	54.40	12.90	44.20	-	-	1.00	0.05	0.05	Akar 0.30	1290	1297	4065	Army guns and mortars
NglBlP-11.5	57.75	12.75	38.50	-	-	3.60	0.05	0.10	-	1150	1159	3550	Army guns and mortars
NglRP - 9.5 (RPC/12 or RP-12 of the Navy)	64.15	11.90	29.77	-	-	5.75	0.25	0.10	-	950	938	2975	Army & Navy guns
NglRP -8	67.07	11.40	26.08	-	-	6.50	0.25	0.10	-	840	827	2650	Army guns
(NglRP 32 or RPC/32	66.60	11.50	25.90	-	-	7.25	0.15	0.10	-	830	816	2630	Navy guns
DiglBlP 10.5	63.62	13.00	-	35.78	-	0.25	0.05	0.05	Akar 0.25	1020	1005	3150	Army howitzers
DiglRP 9.5	61.80	12.60	-	36.45	-	1.50	0.15	0.10	-	950	933	2940	Army guns
DiglRP 8-0.3	68.30	11.90	-	29.25	-	2.20	0.15	0.10	KNO_3 0.30	870	840	2650	37mm AA guns
DiglRP 8.2	67.70	11.90	-	29.05	-	3.00	0.15	0.10	-	820	809	2570	AA and Army guns
(Digl)RP 38 or RPC/38	69.45	12.20	-	35.30	-	5.00	0.15	0.10	-	810	765	2495	Navy guns
(Digl)RP-38N	68.72	12.20	-	25.03	-	1.50	0.15	0.10	MNN 4.50	810	774	2545	Navy guns
(Digl)RP - E	60.55	12.00	-	25.95	-	3.75	0.15	0.10	MNN 2.50 DNT 4.00 Hydr 3.00	730	638	2175	Army and Navy guns
DiglRP - KO or DiglRP - K1	64.15	12.00	-	27.50	-	5.35	0.15	0.10	Vasel 1.85 DAmPh 0.90	725	634	2125	AA guns
	Note: May contain up to 1% K_2SO_4												
DiglRP - KN	61.08	12.00	-	26.17	-	7.00	0.15	0.10	Vasel 1.25 DNT 0.25 KNO_3 4.00	730	665	2125	AA guns
DiglRP - KOO	69.92	12.00	-	14.83	-	3.00	0.15	0.10	MNN 2.00 DNT 10.00	730	644	2190	AA guns
DiglRP GO	62.40	12.00	-	26.75	-	8.00	0.15	0.10	Vasel 1.80 DAmPh 0.80	700	550	1910	Army guns
DiglRP GO.5 or DiglRP G1	61.88	12.00	-	26.52	-	7.75	0.15	0.10	Vasel 1.80 DAmPh 0.80 KNO_3 1.00	700	565	1905	Army guns
DiglRP G1.5 or DiglRP G2	61.60	12.00	-	26.40	-	7.50	0.15	0.10	Vasel 1.60 DAmPh 0.65 KNO_3 3.00	700	607	1920	Army guns
DiglRP G2.5 or DiglRP G3	61.42	12.00	-	26.33	-	7.00	0.15	0.10	Vasel 1.50 DAmPh 0.50 KNO_3 3.00	700	638	1965	Army guns
DiglRP G5	60.73	12.00	-	26.02	-	6.50	0.15	0.10	Vasel 1.25 DAmPh 0.25 KNO_3 5.00	700	652	2020	Army guns

Table 47 (cont'd)

(Digl)RP-40	67.35	11.45	-	24.60	-	7.50	0.25	0.10		720	618	2040	Navy guns
(Digl)RP-40N	64.87	12.20	-	23.65	-	-	0.15	0.10	Akar 0.50 EtPhUr 2.75 DPhUr 1.00 MNN 7.00	730	635	2185	Navy guns
(Digl)L gRP-40N	67.72	11.50	-	-	-	4.20	0.15	0.10	TEGDN 22.38 MNN 5.25 KNO_3 4.00 (added)	650	594	1755	Navy guns
GuP-AO to GuP-A1.2	38.17	13.00	-	31.25	30.00	-	-	0.10	Akar 0.50	930	920 (914)	2880	Army guns
	Note: May contain up to 1.20% K_2SO_4												
GuRP-39	33.49	12.20	-	21.76	40.00	-	0.25	0.10	Akar 0.50 EtPhUr 0.70 DPhUr 0.70 K_2SO_4 0.50	830	794	2550	Navy guns
GuRP-7,5	42.70	12.00	-	18.30	30.00	-	0.15	0.10	EtPhUr 3.75 DPhUr 5.00	750	590	2020	AA and Army guns
GuRP-8	48.13	12.00	-	20.62	30.00	-	0.15	0.10	EtPhUr 1.00	810	827	2630	Army guns
GuRP-KN	39.55	12.00	-	16.95	30.00	-	0.15	0.10	EtPhUr 5.00 DPhUr 4.25 KNO_3 4.00	730	600	1995	AA guns
GuRP-G0 to GuRP-G1	42.70	12.00	-	18.30	30.00	-	0.15	0.10	Akar 0.50 EtPhUr 3.75 DPhUr 4.50	730	590 (588)	2005	Army guns
	Note: May contain up to [illegible] K_2SO_4												
GuP-G5	42.50	12.00	-	18.25	25.00	-	0.15	0.10	EtPhUr 4.50 DPhUr 4.50 K_2SO_4 5.00	730	567	1890	Army guns

Abbreviations: A such as in GuP-AO or GuP-A1.2 indicated a hot NGu propellant (calorific value about 920 kcal/kg) which contained either 0% or 1.2% K_2SO_4; Akar Akardit (Acardite); Am Ammonium; Ammo Ammunition; A/T Antitank; BlP Blättchenpulver (Rectangular flaked propellant); C Construktion (Pattern) such as in C/38 (pattern 1938); Centr Centralite; D indicated the presence of DNT (See also KOD); DAmPh Diamylphthalate; DEGDN Diethyleneglycol dinitrate; DiglP Diglykol (nitrat) Pulver (DEGDN propellant), DNT Dinitrotoluene; DPhUr Diphenylurethane; E(Einheitspulver) "Standard" propellant, such as (Digl) RP-E; EtPhUr Ethylphenylurethane; Exper Experimental; G, such as in DiglRP-G0 to DiglRP-G5, indicated the presence of 0% to 5% of K_2SO_4; Graph Graphite; GuP Gudolpulver (NGu propellant); Hydr Hydrocellulose; K (Krumbach) indicated DEGDN propellants containing K nitrate. These propellants were slightly hotter than the "G" Pulver, having calorific values of 710 to 730 kcal/kg; KN indicated an unspecified amount of K nitrate present; KOD Indicated that K nitrate was not present but some DNT; ManP Manöverpulver (Blank propellant); MNN Mononitronaphthalene (alpha); N Nitrogen; N, such as in RP-38N, indicated the presence of MNN; N, such as in KN, indicated Kaliumnitrat(K nitrate); NC Nitrocellulose; NG Nitroglycerin; NGu Nitroguanidin; NP Nudelpulver (Chopped cord propellant); Nz Nitrozellulose (NC); OD See KOD; PlP Plättchenpulver (Circular discs, without holes, propellant); RgP Ringpulver (Circular discs, with central holes, propellant); RP Röhrenpulver (Long tube propellant); StrP Streifenpulver (Long strip propellant); TEGN Triethyleneglycol dinitrate; Temp Temperature; Theor Theoretical; TriglP Triglykol (nitrat) Pulver (TEGDN propellant).

Table 48

Propellant Igniters and Propellant Igniter Bag Compositions

Form	Composition, %								Uses
	NC	%N in NC	NG	DEGDN	Cent	Graph	Other Ingredients		
Cord	99.1	13.1	-	-	-	-	DPhA	0.9	20 mm Solothurn
Grains	91.3	13.0	-	5.2	1.0	0.3	K sulfate Unac	0.5 1.7	37 mm APHV
Bag	89.6	12.4	-	9.6	0.8	-	-		37 mm APHV (Bag)
Grains	91.4	13.0	-	6.0	0.6	-	Camphor K sulfate Unac	0.4 0.3 1.3	37 mm APRN
Bag	88.9	12.4	-	10.3	0.8	-	-		37 mm APRN (Bag)
Cord	92.8	12.7	3.2	-	1.9	0.3	DPhA Unac	0.3 1.5	37 mm HEHoC
Grain	85.6	12.9	-	10.3	1.0	0.9	Unac	2.2	42/28 mm APHV
Grain	89.5	13.0	-	7.2	0.9	0.4	Unac	2.0	42/28 mm AP Tapered Bore Gun
Cord	88.8	13.1	-	-	6.8	0.35	Acar DNT K salts Unac	0.15 2.5 0.8 0.6	50 mm APC
Bag	91.0	12.3	6.1	-	1.8	-	DNT	1.1	50 mm APC (Bag)
Grains	92.8	13.0	-	4.3	0.4	0.30	K sulfate Unac	0.45 1.75	50 mm APC
Bag	90.4	12.3	-	8.7	0.9	-	-		50 mm APC (Bag)
Grains	88.2	12.3	-	7.0	2.5	0.60	K sulfate Unac	0.3 1.4	50 mm APRN
Bag	88.9	13.0	-	10.3	0.8	-	-		50 mm APRN (bag)
Grains	87.7	12.9	-	7.9	1.9	0.40	Camphor Unac	0.7 1.4	50 mm APRN
Bag	89.1	12.4	-	10.0	0.9	-	-		50 mm APRN (Bag)
Grains	91.3	13.0	-	5.0	0.9	0.25	K sulfate Unac	0.5 2.05	50 mm HE
Bag	96.6	12.6	-	-	-	-	Unac	3.4	50 mm HE (Bag)
Cord	83.4	13.1	-	11.7	1.5	1.0	Unac	2.4	75 mm HE HoC
Bag	87.9	12.6	-	10.8	1.3	-		-	75 mm HEHoC (Bag)
Cord	88.7	13.1	-	6.6	1.4	0.5 (incorp)	Unac	2.8	75 mm HE, A/T (Pak 40)
Cord	77.3	13.0	-	18.8	2.6	0.5	Unac	0.8	75 mm APCLC
Grain	89.1	13.0	-	7.3	0.7	0.5	Unac	2.4	76.2 mm A/T Gun (Captured Russian)
Cord	90.7	12.9	-	5.9	-	-	K sulfate Unac	0.4 3.0	88 mm HE
Cord	92.7	13.1	-	1.7	1.3	-	K nitrate Unac	1.3 3.0	88 mm HELC
Cord	89.1	13.0	5.1	2.1	0.8	-	Acar Unac	0.8 2.1	100 mm Gun (K 18) (Charge 1)
Square	56.7	13.1	32.1	7.0	0.6	-	DPhUret DEtUret Unac	0.8 0.5 2.3	100 mm Gun (K 18) (Charge 2)
Bag	34.9	12.1	63.1 (or DEGDN)	-	0.8	-	Unac	1.2	100 mm Gun (K 18) (Bag)
Square	61.6	13.3	-	36.8	0.4	-	Acar Unac	0.3 0.9	155 mm How
Bag	73.4	12.4	23.0	-	2.4	-	Unac	1.2	155 mm How (Bag)
	84.1	12.7	10.0	-	0.8	-	Acar Unac	2.4 2.7	210 mm Rocket Igniter Pad

Abbreviations: See under table 44

Note: Due to the difficulty of igniting propellants containing DEGDN and NGu, the igniters for these materials consisted of NC of a high degree of nitration with not more than 5% DEGDN.

f) Nodular or noodle (Nudelpulver), designated as NP (or NdP) (1.5 x 1.5), consisted of grains 1.5 mm long and 1.5 mm in diameter.

g) Long (Langpulver), used for Naval star shells and designated as LgP (480 x 3.9/2.8), consisted of tubular grains 480 mm long having external and internal diameters of 3.9 mm and 2.8 mm respectively.

(See also Table 46 of this book where web dimensions and ballistic characteristics of typical German propellants are given).

Propellant Igniters and Propellant Igniter Bag Compositions. According to the work conducted at Picatinny Arsenal during WW II most of the bags (containers) used for propellant igniter compositions were made of colloided smokeless propellant materials. The same investigation showed that the propellant igniter compositions may be subdivided into three classes:

a) NC-NG compositions

b) NC-DEGDN compositions and

c) Black powder compositions.

Table 48 gives the composition of typical propellant igniters, classes (a) and (b), and of their containers (bags). It is to be noted that the values shall be considered as only approximate because there was a possibility that some of the NG or DEGDN volatilized and passed from the propellant to the bag or vice versa.

(See previous page).

Some propellant igniter compositions of Class c (black powder) are given in Table 49

Table 49

Form	Composition, %			Uses
	KNO_3	Sulfur	Charcoal	
Grain	75.9	9.5	14.6	20 mm Inc
Grain	77.5	9.5	13.0	20 mm AP
Grain	74.9	9.9	15.2	20 mm HE
Grain	74.2	8.96	16.84	47 mm APC
Grain	76.2	9.8	14.0	47 mm AP LN

Abbreviations See under Table 44.

According to Ref 4, one of the propellant igniter compositions manufd at the Düneberg Fabrik D A -G contained: NC (13%N content) 54.39, NG 44.51, Acardite 1.00, MgO 0.05, and IG Farben Wax E 0.05%. Oxygen balance + 10.96% and calorific value 1284 kcal/kg.

According to Ref 5, one type of German igniter for propellants consisted of NC (13.15%N) 75.8, NG 24.0, and DPhA 0.2%.

References:
1) Picatinny Arsenal Technical Reports 1282 (1943) and 1456 (1944)
2) PB Rept 11,544 (1945)
3) Pic Arsn Tech Rept 1555 (1943)
4) PB Rept 7826 (Technical Intelligence Rept 1-70) (1945)
5) J.Corner, Theory of Internal Ballistics, Wiley (1950, p 29.

Propellant Substitutes. See Treibsätze.

Proving of Ammunition and Weapons. Preliminary testing was done at proof ranges attached to most of the explosives, ammunition or weapons plants such as those of the Dynamit A -G, WASAG, Krupp, etc, but final (acceptance) tests were conducted either at the Hillersleben (for the Army) or at the Meppen (for the Navy) Proving Grounds.

Most of the German proof ranges were built in the form of a V, the gun being placed at the point of intersection, so that it could fire into one butt while the other was being prepared. The officer in charge sat in an upstairs office behind the gun and overlooking it. The LeBoulengé chronographs were in other buildings further back and results were sent to the officer through a pipe conveyor system. The LeBoulengé screens were usually placed 50 m apart at approximately 30 and 80 m from the gun.

The proof procedure for a propellant was to fire it in comparison with a standard propellant, using 7 rounds of each lot under proof. A normal lot was 50 tons. The firing temperature was 10°C for the Army and 15°C for the Navy. Propellant charges for use in the tropics were made to give the same ballistics at 25°C as the normal charge at 10°C. The upper temperature for tropical A/T propellants was 60°C. Propellants were stored at the required temperature for at least two days prior to firing.

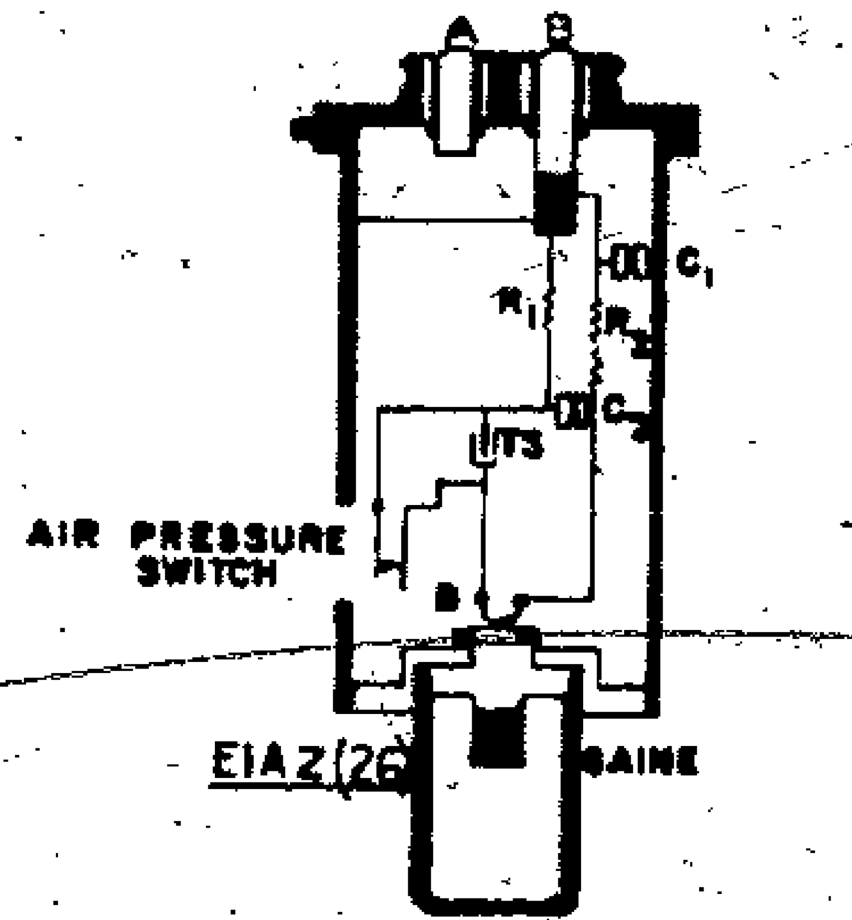
Chamber pressures were measured by copper cylinders (crusher gages).

The proof procedure for a gun was to heat a Service propelling charge to 35°C and use it in the gun being proved, attempting to develop a pressure (design or true pressure) of about 300 atm (sq tons/sq in) above the proof pressure, as measured by a copper crusher gage. For the Adolf gun the pressure above the proof pressure, was only 150 atm (1 ton/sq in).

Reference: H.H.M.Pike, CIOS Rept 31-68 (1946), pp 10-12.

Proximity Fuze. According to TM 9-1985-2 (1953), three types of proximity fuzes, for use in bombs, were developed in Germany: the Acoustic, the IR (infra-red) and the Electronic.

Among these the Kranich (briefly described on pp 216-17) was acoustic, the Madrid (developed by Kapka of Vienna and mentioned on p 232) was infrared, and there were also electronic fuzes developed by the Telefunken Co and others. Several other names of proximity fuzes are mentioned on p 229, such as Kakadu, Marabu and Fuchs, but the type of each of these was not stated.



A different type of proximity fuze is described in TM E9-1985 (1942), File N 2327.6. This fuze, designated as EIAZ (26), was cylindrical in shape and contained the charging plungers A and B (surrounded by insulating material), a charging condenser C_1, a firing condenser C_2, resistances R_1 & R_2, an igniter bridge IB, a trembler switch TS and an air pressure switch. The latter switch consisted of a fixed and a movable plate. The switch was placed just inside of an opening in the fuze case and was aligned with the air tube leading from the nose of the bomb C250 Flam. (See drawing).

The base of the fuze case was threaded to receive the gaine, which housed the primer (containing a match composition and black powder), the detonator (containing lead azide/lead styphnate mixture over PETN and PETN/wax) and the booster (picric acid).

Before the bomb was dropped from a plane the current from the plane batteries passed through B (plunger A was a dummy) into C, and at the release of the bomb the current leaked slowly through R_2 to C_2 where it accumulated. As the bomb approached its target the pressure of air built up in the tube leading to the pressure switch) pushed the movable plate of the switch towards the fixed plate, thus closing the circuit through IB and firing the gaine and eventually the main charge of the bomb.

If the pressure fuze should fail to operate then the trembler switch TS was supposed to act on impact of the bomb.

Note: According to G.E.Rogers of Picatinny Arsenal, this type of fuze could be initiated by the air burst produced by other bombs exploding in the vicinity and this would be undesirable if the bomb was not yet close to its target. On the other hand this property of the fuze could be used to intentionally produce air bursts of bombs by dropping them in a train.

Proximity Fuze, Electric, EIAZ (26). See under Proximity Fuze.

Pudel (Poodle). An acoustic homing device intended for the control of some guided missiles. Its construction was essentially the same as for the Kranich acoustic proximity fuze. Reference: TM 9-1985-2 (1953), p 217.

Pull Type Igniter (Zugzünder). See under Igniter.

Pulver (Powder). See also Propellant.

Following are the principal German abbreviations used to designate various types of propellants:

a) **Pulver Digl** (Typ Digl). A double-base propellant contg as principal ingredients DEGDN and NC

b) **Pulver Gu** (Gudol). A triple-base propellant consisting of NGu, NC and DEGDN

c) **Pulver Ngl** (Typ Ngl). A triple-base propellant consisting of NGu, NC and DEGDN

d) **Pulver Nz** (Typ Nz). A single-base (NC) propellant

e) **Pulver OL** (Pulver ohne Lösungsmittel) A solventless propellant

f) **Blättchenpulver** (BlP). A leaf or flake propellant

g) **Ringpulver** (RgP). An annular propellant, resembling a washer

h) **Röhrenpulver** (RP). A tubular propellant

i) **Streifenpulver** (StrP). A strip propellant

j) **Würfelpulver** (WP). A propellant in small rectangular tablets; it is called (sometimes) cube-cut propellant.

Reference: TM 9-1985.

Pulvermasse G. A double-base propellant containing K sulfate as a flash-reducing agent.

Pulvermetallurgie (Powder Metallurgy). The technique of powder metallurgy was applied on a considerable scale during WW II, chiefly in the production of carbide tools and some ammunition and weapon components. For instance, the following articles were manufd from sintered iron or steel: shell driving bands ranging from 20 to 210 mm in caliber (sintered iron), fuze bodies and bullet cores (sintered steel) and also bearings, rings, gears, etc.

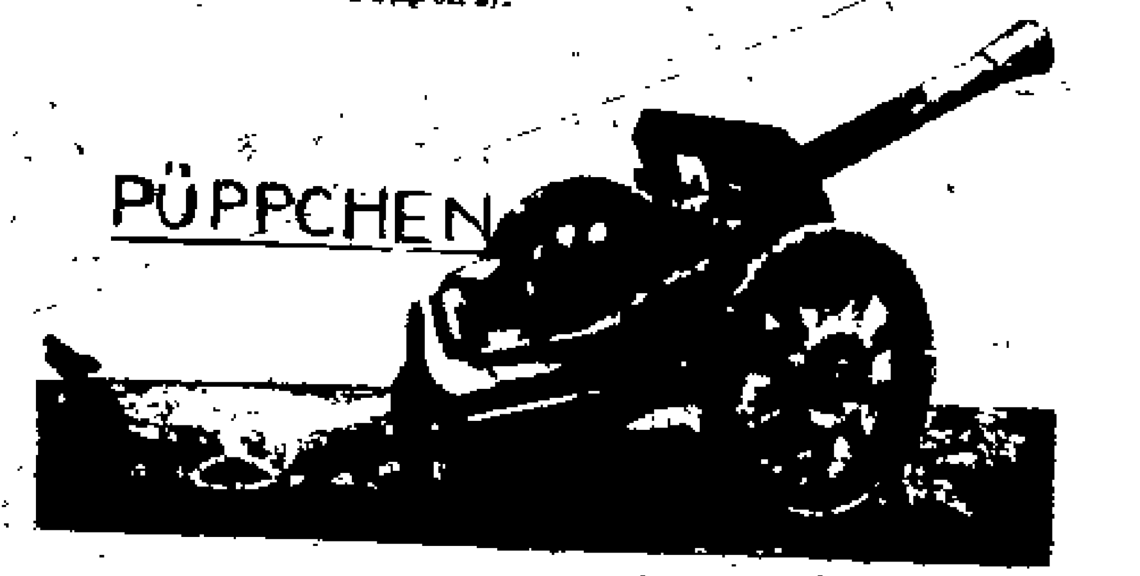
Reference: C.J.Leadbeater, Sintered Iron and Steel Components, BIOS Final Rept 595, Item 21 (1945).

Pulvermetallurgie (as practiced by the DPG). A jet of molten iron together with a strong jet of water were directed against a fast rotating horizontal disc enclosed in a cylinder having a conical bottom provided with an outlet. The resulting product, powdered iron slightly oxidized on the surface, was dusted with a small amount of yellow lead oxide and then reduced in an atmosphere of hydrogen at about 400°C. By this process the iron particles became coated with lead and thus rendered rust-proof. This powder was used for the prepn of sintered iron rotating bands (in lieu of copper bearings and other articles Dr H. Kalter - Private communication.

Pulwitz of Berlin patented, in 1895 the following permissible explosive: Am nitrate 92.0, phenanthrene 5.5 and K bichromate 2.5%. [Daniel, Dictionnaire, Paris (1902), p 659].

Püppchen (Dolly), called also **Wheeled Bazooka** was a carriage-mounted 88 mm rocket launcher with breech-block. It used ammunition containing the same shaped-charge warhead as the Panzerschreck (Ofenrohr) but with a shorter rocket motor body. It was fired by means of a propellant contained in a cartridge placed in the breech. The flash from the cartridge ignited the rocket propellant and the missile proceded towards the target.

Reference: Intelligence Bulletin, March 1945, p 14 (See also under 88 mm Weapons).



Pyrofulmin. See general section.

Pyrolit (Pyrolithe). According to Naoúm (Ref 1) Pyrolit was a type of explosive prepd from smokeless propellants left over after WW I. The finished product also contained 5 to 12% gypsum and at least 18% moisture. Na nitrate and/or K perchlorate (max 30%) and TNT (max 15%) were sometimes incorporated in Pyrolit.

J.Pepin Lehalleur (Ref 2) lists the following compositions, called pyrolithes:

a) Ballistite 74-76 and Na nitrate with or without $KClO_3$ 26-24%

b) Ballistite 40-42, K chlorate with or without Na nitrate 45-43 and aromatic nitrocompounds 13-15%.

Note: The aromatic nitrocompounds of the last composition should not increase the sensitiviness to shock to any greater extent than the addition of 13-15% TNT.

References:
1) P.Naoúm, Nitroglycerin, etc, Baltimore (1928), p 451
2) J.Pepin Lehalleur, Poudres, etc, Paris (1935), pp 457-8.

Pyroschliff. Pulverized aluminum intended for use in pyrotechnic compositions. It was required that the moisture content be 0.4% (max), and fats 0.6% (max).

Reference:

Kast-Metz, Chemische Untersuchung der Spreng- und Zündstoffe, Vieweg, Braunschweig, (1944), p 516.

Note: According to TM 9-1985-2 (1953), p 82, the Pyroschliff was an extremely fine, low density, flaked aluminum (Al) powder having the following characteristics: Al metal content 87-92, fat content less than 0.1 and moisture content 0.5%, the rest being unspecified impurities. Straight Pyroschliff was used for filling the BLC 50/A bomb described under Photoflash Bombs.

Pyrotechnic Antipathfinder Devices, such as the 15 cm simulator rocket and Mark 50 cascade flare bomb, were employed as a counter measure for the Allies' Pathfinder Bombing (q v). The German devices were intended to confuse the raiders by false signals which closely resembled the signals employed in the Pathfinder system. The devices were launched into the air by means of rockets, or were dropped from planes about 5 miles away from the true targets and over unimportant territory.

Against the daylight raids each rocket was equipped with either three smoke flares or with about 300 pellets designed to produce black smoke trails. Against the night raids there were many different arrangements of colored lights.

It was reported that the German devices were used also to designate landing fields to the Luftwaffe pilots during heavy fog. Another use was to indicate the direction and magnitude of Allied air attacks to Flak batteries and Luftwaffe fighter pilots.

Following is a brief description of some Antipathfinder devices:

A. 15 cm RSSG (Raketen Scheinschussgerät) Rocket Signal Simulating Device) was constructed of two sections: the rocket motor tube and the rocket head

The tube contained seven 2 lb sticks of NC-DEGDN rocket propellant, while the head contained a pyrotechnic charge such as:

1) "F" (Fallschirm) Patronen (Parachute Flare Cartridges) which contained, among other items, the red, green, yellow or white flare compositions.

For instance, the red flare cartridge consisted of the following components:

a) First fire (1.5 g of black powder)

b) Intermediate (1.5 g of a mixture of K nitrate 46.2, S 11.4, Al 10.3, black powder 29.3 and Zr 2.8%)

c) Igniter (17 g of a mixture of Sr nitrate 61, PVC 22 and Mg 17%)

d) Red flare (6.7 kg of a mixture of Sr nitrate 60, CPVC 18, Mg 18, IG wax 3 and vaseline 1%). Burning time 5 minutes.

Other flares had the following compositions:

Green flare. Ba nitrate 60, CPVC 20, Mg 17, IG wax 1 and vaseline 2%. Burning time about 5 minutes.

Yellow flare. Na nitrate 45, Sr nitrate 2, Mg/Al alloy (50/50) 40, wood meal 3, IG wax 8 and vaseline 2%. Burning time 5 minutes

White flare. Ba nitrate 68.5, K nitrate 8.0, Al 17.5, S 4.0 and vaseline 2.0%. Burning time 5 minutes

Note: The composition of the first fire and of the intermediate mixture was the same for all flares, but the ignition compositions were as follows:

For green flare: 17 g of a mixture of Ba nitrate 60, CPVC 23, Mg 14, IG wax 1 and vaseline 2%.

For yellow and white flares: 17 g of a mixture of Ba nitrate 62, Ba fluoride 6, S 10, Al (flakes) 20 and Al (grains) 2%.

The cartridge for the green star consisted of the following items:

a) Primer

b) First fire (1.5 g of black powder)

c) Intermediate (1.0 g of mixture: K nitrate 45, S 13, Al 10 and black powder 32%)

d) Red star (10.0 g of a mixture of Ba nitrate 57, Mg 20 and CPVC 23%).

The composition for the red star was: Sr nitrate 60, Mg 24 and CPVC 16%). The first fire was the same as for the green star, but the intermediate contained: Ba nitrate 31.2 K nitrate 15.4, Al 10.9, S 11.7 and black powder 30.8%.

Note: Most of the intermediate compositions containing black powder and sulfur, were replaced, in 1945, by mixtures contg tetranitrocarbazole, K nitrate and Al and the reason for this is explained under Tetranitrocarbazol (TeNCbz).

2) "Ks" (Kaskade) Patronen (Cascade Cartridges) contained flares (green, red, yellow or white) without parachutes.

The following combination was used for green flare:

a) Igniter (5 g of black powder)

b) Intermediate (7.5 g of a mixture of K nitrate 34, TeNCbz 34 and Al 32%.

c) Green flare [320 g of a mixture of Ba nitrate 61, CPVC (63% Cl) 21, Mg 11 and IG wax 7%]. Burning time 2 minutes and candlepower 10000.

Note: The composition of the red flare was: Sr nitrate 62.5, Mg 13.5, CPVC (63% Cl) 18.0 and IG wax 6.0%. Burning time 2 minutes and candlepower 10000.

3) "Rz" Rauch Patronen (Smoke Cartridges) contained three smoke candles (Nebelkerzen 39B) consisting of a mixture of HCE 40, Zn dust 50 and Ba nitrate 10%. Burning time 1 minute.

4) Black Smoke Cartridges, which contained about 300 smoke producing pellets of the following composition: HCE 61.5, Mg 18.5, anthracene 8.0 and naphthalene 12.0%. The igniter train consisted of a black powder and an ignition composition containing K nitrate 24.0, HCE 24.6, TeNCbz 18.0, anthracene 5.6, naphthalene 2.4, Al powder 18.0 and Mg powder 7.4%.

Note: There were two types of 15 cm RSSG rockets (1 and 2). Type 1 was equipped with a delay igniter V-22 (q v) which was fired by the hot gases from the propellant, while type 2 was equipped with the electrical igniter for the rocket motor tube and was ignited separately.

B. 15 cm RLGS (Raketen Leuchtgerät Scheingeschoss Rocket Illuminant Simulating Device) was an improved version of the 15 cm RSSG rocket. The RLGS rocket used flares of the following types:

1) Single color flares: red, green or yellow

2) Red, green and yellow flares which ejected seven groups of colored stars, at intervals of about 25 seconds.

For instance, the green flare cartridge consisted of the following items:

a) First fire (1 g of black powder)

b) Intermediate (1.5 g of a mixture of TeNCbz 30, Al 30 and K nitrate 40%)

c) Igniter (20 g of a mixture of Ba nitrate 60, Mg 20 and PVC 20%

d) Green flare (1.15 kg of a mixture of Ba nitrate 57.5, Mg 7.5, Mg/Al alloy (50/50) 6.5 and PVC 28.5%. Burning time 4 minutes).

For flares which burned with the ejection of stars, the composition was not the same as for ordinary flares. For instance, the green flare employed for ejection of stars contained: Ba nitrate 53, Mg 25, PVC 20 and graphite 2%. The corresponding stars contained: Ba nitrate 55, Mg 18, PVC 25 and graphite 2%.

The composition of other flares and their stars is given on pp 27-29 of the Reference

C. Mark 50 Kaskade (Cascade Flare Bomb) was employed to simulate the cascades of the Pathfinder system used by the Allies. It consisted of a cardboard case filled with about 62 candles. Each candle burned for about 2 minutes with either a red or green flame. The composition of the candles was the same as described for item A2, "Ks" (Kaskade) Patronen.

Abbreviations: CPVC Chlorinated polyvinyl chloride; DEGDN Diethyleneglycol dinitrate; HCE Hexachloroethane; PVC Polyvinylchloride; TeNCbz Tetranitrocarbazol.

Reference: H.J.Eppig, Pyrotechnic Antipathfinder Devices, CIOS, Item Nos 3 & 17, File No 32-56 (1948).

PYROTECHNICS (Feuerwerkerei). The compositions of various pyrotechnic devices in use between WW I and WW II were given by Langhans (Ref 1) and Lenze (Ref 2). The latter investigator also described various tests applied to pyrotechnic compositions, such as Entzündlichkeit (Ignitability), Entzündungstemperature (Ignition Temperature), Empfindlichkeit gegen Schlag und Reibung (Sensitiveness to Shock and Friction), Detonationsgeschwindigkeit (Velocity of Detonation) and Brisanz (Brisance).

A brief historical description of the development of the science of pyrotechnics in Germany is given by Lotz (Ref 3).

Izzo (Ref 5) lists numerous German pyrotechnic compositions as can be seen in Table 50. (See next page).

Table 50
Pyrotechnic Compositions

Designation	Chlorate of: Ba	Chlorate of: K	Nitrate of: Ba	Nitrate of: K	Nitrate of: Sr	Al	Mg	S	Sr	Zr	Shellac	Other Ingredients	Reference
Green Star signal	64.0	18.0	-	-	-	-	-	-	-	-	18.0		5,p 211
Green Light (1944)	-	-	58.0	-	-	-	7.5	-	-	-	-	PVC 22.5 Si 7.0 Res Ac 5.0	5,p 211
Signal Light	-	23.8	57.1	-	-	-	-	19.1	-	-	-	-	5,p 212
Signal Light	-	21.4	57.2	-	-	-	-	10.7	-	-	-	Charcoal 10.7	5,p 212
Signal Light	-	11.1	66.7	-	-	-	-	-	-	-	22.2	-	5,p 212
Signal Light	-	36.0	40.0	-	-	-	-	24.0	-	-	-	-	5,p 212
Signal Light	81.1	-	-	-	-	-	-	10.8	-	-	-	Charcoal 2.7 Calomel 5.4	5,p 212
Signal Light	-	32.7	52.3	-	-	-	-	9.8	-	-	-	Charcoal 5.2	5,p 212
Ignition Composition	-	-	16.0	16.0	-	10.0	-	8.0	-	-	-	Black powder 50.0	5,p 221
"	-	-	-	46.0	-	11.0	-	11.0	-	3.0	-	Black powder 29.0	5,p 221
"	-	-	-	40.0	-	30.0	-	-	-	-	-	TeNCbz 30.0	5,p 221
Green Star Signal	-	-	58.0	-	-	-	8.0	-	7.0	-	-	PVC 22.0 Gallic or Res Ac 5.0	5,p 228 - 9
Green Star Signal	-	-	55.0	-	-	-	16.0	-	-	-	-	PVC 29.0	
Red Star Signal	-	-	-	-	55.0	-	28.0	-	-	-	-	PVC 17.0	"
Red Star Signal	-	-	-	-	50.0	-	32.0	-	-	-	-	PVC 18.0	"
Red Star Signal	86.0	-	-	-	-	-	-	-	-	-	11.0	Carbon 3.0	5,p 229

Abbreviations: PVC Polyvinyl chloride; Res Ac Resorcylic acid; TeNCbz Tetranitrocarbazole.

Notes:

a) Duration of flame for a 12 g star signal was about 7 seconds

b) For igniting each star composition of the signal about 1 g of black powder was used. This in turn ignited about 1 g of the intermediate mixture containing K nitrate 30.6, Ba nitrate 39.1, carbon 9.2 and Al 21.1%.

In the article by Goldenson and Danner (Ref 4) the following compositions are listed:

A) Hand smoke signals:

a) Red: K chlorate 17, lactose 24 and o-methoxyphenylazo-beta-napthol 59%

b) Blue: K chlorate 30, lactose 20 and 1-methylamino-4-p-toluidinoanthraquinone 50%

c) Green: K chlorate 29, lactose 24, 9 10-dianilinoanthracene 30 and 1-methylamino-4-p-toluidinoanthraquinone 16% (Adds to 99%)

d) Violet (Rauchbündelpatrone Violett): K chlorate 25, 1-methylamino-4-p-toluidinoanthraquinone 15, lactose 50 and "Rhodamine B" 10%. It was fired from a Very-type pistol to produce four streaks of bright violet smoke.

B) Whistling cartridge (Pfeifpatrone) Contained two mixtures:

a) Ba nitrate 55.5, Al powder 35.5 and sulfur 9%

b) K chlorate 65.5 and gallic acid 33.5% (Adds to 99%).

Note: Mixture (a) was for producing light, while mixture (b) produced a whistling sound. The cartridge was designed to be used as a gas attack warning.

C) Frangible grenade which produced a white screening smoke by the hydrolysis of titanium tetrachloride with water in which was dissolved 27 parts of Ca chloride (to prevent freezing)

D) Tank-gun smoke-screen projectile which contained oleum adsorbed on pumice. Another projectile was filled with solid SO_3.

Additional information, given below, was obtained from Refs 9-17:

A. Pyrotechnic items of Ref 9 are discussed in this work under Incendiary Compositions and Smoke Compositions.

B. Pyrotechnic items briefly discussed in Ref 10 include:

a) LC 50 flares, 8" diameter

b) Ground flares, 4.5" diameter

c) Self contained signal rocket

d) 2 star red signal, hand operated by a pull igniter.

C. Pyrotechnic items of Ref 11 are discussed in this work under Pyrotechnic Antipathfinder Devices.

D. Pyrotechnic items of Ref 12 are discussed in this work under Tracers.

E. Pyrotechnic items of Ref 13 include the following:

a) Compositions for the different colored candles used in Mk 50 Kaskade Bombe include Red: Sr nitrate 56, Mg 16, Igelit 21 and IG wax 7%; Green: Ba nitrate 56, Mg 16, Igelit 21 and IG wax 7%; Yellow: Ba nitrate 61.5, Mg 15, cryolite 8.5, IG wax 4, Igelit 6 and Ca oxalate 5%; White: Ba nitrate 59, Mg 11, K nitrate 21, IG wax 6 and Igelit 3%

b) Flare composition used in the ground flare, Bodenleuchte (P) F156217: Mg (granular) 34.6, Na nitrate 11.3, gypsum 45.5 and water 8.6%

c) Blue light composition used for ship signals consisted of K nitrate, sulfur and Sb sulfide

d) Red light composition for ship signals contained K chlorate, shellac and Sr oxalate

F. Items mentioned in Ref 14 include some firework devices, such as paper caps for toy pistols, etc. A typical cap composition was made by mixing K chlorate 70, phosphorus 15 and sulfur with lime suspended in water 15%

G. Pyrotechnic items of Ref 15 include the amorces (q v) and some firework compositions such as Bengal light and star compositions

H. Pyrotechnic items of Ref 16 include the following red colored light mixture used for signalling: Sr nitrate 50-61, Mg 17-35, polyvinyl chloride or chlorinated polyvinyl chloride 14-28 and vaseline or synthetic wax 1-5%.

I. According to Ref 17, the Germans made great use of kieselguhr as an extender for expensive organic dyes and dye intermediates used in their pyrotechnic compositions.

References:

1) A.Langhans, S S 17, 34-36, 43-45, 61-62, 68-70, 77-78, 90-93, 105-106 (1922) Leuchtsätze (Pyrotechnic Compositions)

2) F.Lenze, S S 27, 366-71, 406-9 (1932); Ibid, 28, 14-17 (1933)

3) A.Lotz, Das Feuerwerk, Hiersemann, Leipzig, (1940), pp 19-45, 86 & 89-103

4) J.Goldenson & C.E.Danner, Chem Engr News 26, 1976-8 (1948); C A 42, 6116 (1948)

5) A.Izzo, Pirotecnia e fuochi artificiali, Hoepli, Milano (1950), pp 211, 212, 221 & 227-229

6) F.G.Haverlak, Pic Arsn Tech Rept 1440 (1944) (Tank smoke candles, NbK 39B)

7) F.G.Haverlak, ibid, 1505 (1945). Aircraft colored smoke signals

8) F.G.Haverlak, ibid, 1519 (1945). Colored smoke signals

9) E.V.Bateman, CIOS Report 32-13 (1945), Production of Smoke, Incendiary and Chemical Warfare Weapons

10) C.G. Bridge, CIOS Rept 32-27 (1945), German Pyrotechnics

11) H.L.Eppig, CIOS Rept 32-56 (1945), Pyrotechnic Antipathfinder Devices

12) H.Peploe et al, CIOS Rept 33-20 (1945), Deutsche Waffen und Munitionsfabriken, A -G

13) F/Lt Lisowski & P.Milholland, BIOS Final Rept 1233 (1946), German Pyrotechnic Factories

14) C.G.Davies et al, BIOS Final Rept 1594 (1946), Some German Pyrotechnic and Paper Firms

15) T.M.Bennett, BIOS Final Rept 1313 (1947), German Methods of Production of Amorces and Sundry Pyrotechnic Stores

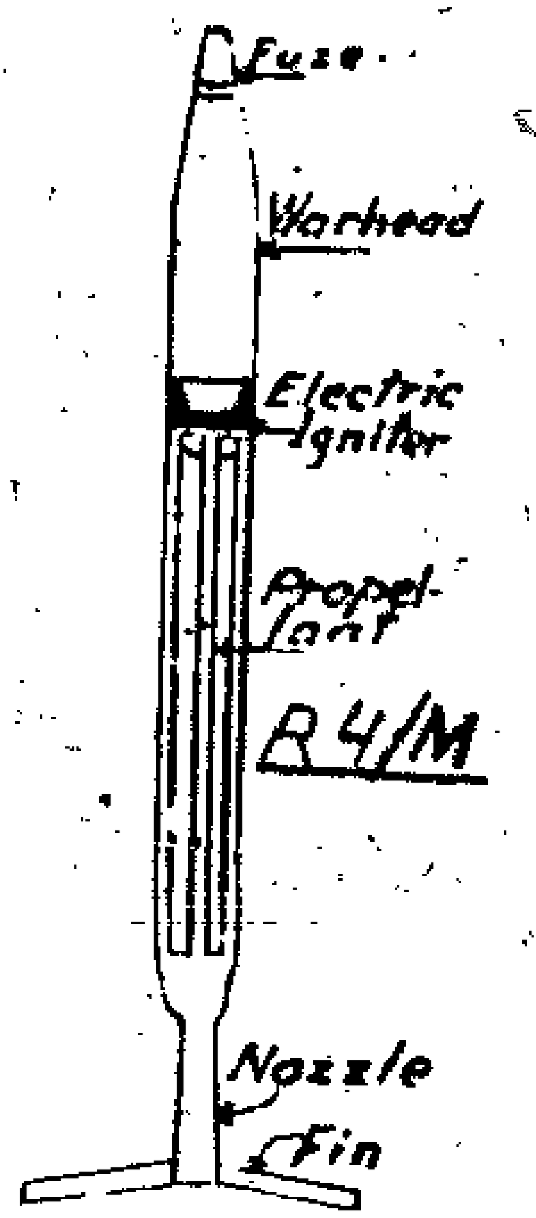
16) T.Urbański, Przemysl Chemiczny 27 (4), 487 (1948), Progress in the Field of Explosives During the Past Decade (Translated from Polish by Dr Ivan Simon)

17) J.Kasegis, PB Rept 102/500 (1951), Colored Smokes (General discussion and some bibliography).

(See also under Illuminating Compositions, Incendiary Compositions, Tracer Compositions, Smoke Compositions, Signal Devices, Flares, and Antipathfinder Pyrotechnic Devices).

Quellungsgrad (Swelling Coefficient). See general section.

R-4M. A 2 inch solid propellant rocket, which carried about 1 lb of a HE and had tail surfaces that could be folded back. It was mass produced towards the end of WW II by the Deutsche Waffen- und Munitionsfabriken at Lübeck. As many as 48 of these missiles could be carried on the underwing racks of a fighter plane and fired practically simultaneously against a bomber formation at a range of 1200 to 1500 yards. It was claimed that a single hit with such a rocket was sufficient to bring down a bomber.



Reference: W.Dornberger, V-2, Viking, N Y (1954), p 270.

Note: According to K.W.Gatland, Development of the Guided Missile, "Flight" Publication, London (1952), pp 122- the R4/M was an air-to-air missile developed in 1944 by modifying the RZ 73 Föhn. Its diameter was 2.16", overall length 2.75 ft, launching weight 7.75 lb, range ½ mile. It used a single tubular grain propellant which had a burning time of 0.8 sec.

Radar Guidance System for Missiles. See under Guidance Systems for Missiles.

Radio Command Guidance Systems. See under Guidance Systems for Missiles.

Rakete. See Rocket.

Raketenpanzerbüchse. See under Weapons, caliber 88 mm.

Raketenwerfer. See under Weapons, caliber 88 mm.

Ramjets. See general section. Some information on German ramjets is given in CIOS Rept 31-13 (1945).

Raschig's White Powder (Weisspulver) (See also Raschit). A cheap blasting powder prepared by F.Raschig in 1911 as follows:

A concentrated solution of a mixture of 65-70 parts of Na nitrate and 35-30 parts of Na cresolsulfonate was run in a thin stream onto a rapidly rotating drum heated by high pressure steam. The thin layer of dehydrated material which formed on the surface of the drum was scraped off in the form of flakes which were packed in waterproof paper cartridges. Compositions patented in 1912, consisted of: a) Na nitrate 68 and "Zellpech" 32% and b) K nitrate 70 and Zellpech 30%.

Note: In selecting the components of such explosives, it was necessary to bear in mind that if their solubility is not of the same order there will be a tendency for the ingredients to separate during the evaporation.

"Zellpech" is a pitch obtained by evaporating the liquor from the sulfite cellulose industry.

References:

1) Marshall, v 1 (1917), p 90

2) Naoúm, Schiess- und Sprengstoffe (1927), p 16

3) Davis (1943), p 50.

Raschit (Raschite). A class of mixtures invented by F. Raschig and prepared in the same manner as Raschig's White Powder. Some Raschites were used as blasting explosives, others were used during WW I as propellants, called Wasserlösliche Schiesspulvern, which means Water-soluble Propellants. Table 51 gives the composition of several Raschites.

Table 51

Designation	Composition, %				
	Am nitrate	Na nitrate	Na benzene sulfonate	Na cresol sulfonate	Zellpech
Raschit 1	74	-	26	-	-
Raschit 2	87	-	13	-	-
Raschit 3	86	-	-	14	-
Raschit 4	69	-	-	31	-
Raschit Type 1	-	65	-	35	-
Raschit Type 2	-	68	-	-	32

Note: Colver (Ref 4, p 352) stated that Raschit was invented in 1911 by Adolf Voight of Germany.

References:

1) F.Raschig, Angew Chem 25, 1194-97 (1912)

2) F.Raschig, S S 7, 292, (1912)

3) Marshall, v 1 (1917), pp 90 & 392

4) Colver (1919), pp 352, 707 and 738

5) J.Pepin Lehalleur, Poudres, etc, Paris (1935), p 287.

Rauchlose Pulver. Smokeless Propellant, also called **Rauchschwaches Pulver,** which means Weak Smoke Propellant or Semi-smokeless Propellant. (See Propellants).

Rauchloses Geschützpulver 1889. See RGP 89 (Pulver).

Rauchloses Rottweiler Pulver. See RRP.

Raupenschlepper (Caterpillar Tractor) was used for towing or carrying large guns and other items for military use. Some information on caterpillar tractors is given in the book by Dr F.v Senger u. Etterlin, Taschenbuch der Panzer 1943-1954, Lehmanns' Verlag, München (1954) G.B.Jarrett, "Achtung Panzer", The Story of German Tanks in WW II, Great Oaks, RD1, Aberdeen, Md (1948).

Raw-Paste. See Rohpulvermasse.

RCP (Rottweiler Cellulose Pulver) (Rottweil Cellulose Propellant). The first German gelatinized military smokeless propellant which was invented in 1883-1884 by Carl Duttenhoffer (born 1843, died 1903) independently of P.Vieille who invented Poudre B (see in the French Section). The first RCP was prepared at the Rottweil Plant by nitrating partially carbonized wood (the same kind as was used for prepn of brown powder, called Pulver C/82) by a method similar to that used in prepn of Schultze's Powder. The nitrated product was stabilized by boiling water, then dried and gelatinized by means of ethyl acetate. The gelatinized product was grained either in the form of small leaflets (Blättchenpulver) for use in rifles or in the form of strips (Streifenpulver) for use in cannons.

References:

1) H.Brunswig, Das rauchlose Pulver, Berlin (1926), pp 6-7

2) P.Tavernier, Mém poud 32, 244 (1950).

Recoilless Gun (Kanone ohne Rücklauf). Several models were developed in Germany between 1937 and the beginning of WW II. Most of these were of Rheinmetall - Borsig Co design. One of the best known was the LG-1-Rh (later designated as LG-40) which was a 75 mm gun with a range of about 6800 yards. It weighed 325 lb (complete), was 45 inches overall and had a barrel 29.5 inches long. It used the Rheinmetall horizontal sliding breechlock which carried the counterblast nozzle.

The larger caliber recoilless guns included:

a) 105 mm, known as LG-2Kp and as LG-40: This had a breech system very similar to that in the Russian recoilless gun which was developed before the Russo-Finnish War. The German model weighed 850 lb complete

b) 105 mm, known as LG-2-Rh, LG-40-1 and LG-40-2, which used the Rheinmetall breech design. It weighed 1200 lbs

c) 155 mm, designated in service as LG-42, weighed about 1400 lb in firing order and projected a shell weighing about 90 lbs

d) DKM (Düsen-Kanone-Marine), developed by Rheinmetall-Borsig Co, was made in two versions: the DKM-43, cal 88 mm, for use on light patrol craft and the giant DKM-44, cal 280 mm. These two guns were still under development at the end of the war, but the DKM-43 was almost ready to be put into production. Both guns were supposed to use the Rheinmetall horizontally sliding breechlock with counterblast nozzle

e) Aircraft recoilless weapons, developed by Rheinmetall-Borsig Co, included the Device 104 (a 14-inch gun firing a 1500 pound AP projectile) and the SG-113A, designed primarily to attack tanks from the air.

f) DUKA 50 and DUKA 88. Two recoilless aircraft weapons produced by Rheinmetall. Data and description of these guns are contradictory and little is known of them

g) Rheinmetall Mk-115 was a 55 mm weapon of very original construction. It was still under development at the end of war

The above weapons were briefly described by R.March, Ordnance 38, 887-78 (1954).

F.G.Haverlack, in Picatinny Arsenal Technical Report 1487 (1945), described a complete round of unfired hollow (shaped) charge used in 75 mm Recoilless Gun, LG-40.

W.W.Fahr, in CIOS Rept 32-108 (1945), described the recoilless gun development of the Rheinmetall-Borsig Co.

Recoilless Mortar, caliber 2", was briefly described by W.Dornberger, V-2, Viking, N Y (1954), p 270. Its projectile weighed 15 lb and travelled at a velocity 1300 ft/sec. The weapon was optically triggered by means of a selenium cell. When the plane's silhouette appeared on the cell, the round was automatically fired.

Recoilless Weapons. Besides recoilless guns and the recoilless mortar described above, the Germans used numerous tubular rocket launchers, such as Panzerfaust, Ofenrohr, Panzerschreck, Püppchen, Panzerwurfmine, etc, which also were, strictly speaking, "recoilless weapons".

References: Intelligence Bulletins, U S War Department, Washington, D C, Vol III, No3 (1945), pp 74-79 and Vol III, No 7 (1945), pp 9-16.

Reducing Bore Gun, Gerlich Type Gun, Squeeze-Bore Gun. See Tapered-Bore Gun.

Reibungsprobe (Friction Test). See in the general section.

Reinforcing Igniter. See Zündverstärker.

Reinol (Pure Trinitrotoluene). See under Trinitrotoluol.

Remote Control Systems for Controlling the Missiles. See Guidance Systems for Missiles.

Research and Development Establishments for ammunition, rockets, rocket fuels, guided missiles, aircraft and weapons are briefly described by L.M.Simon et al in CIOS Report 30-71 (1945).

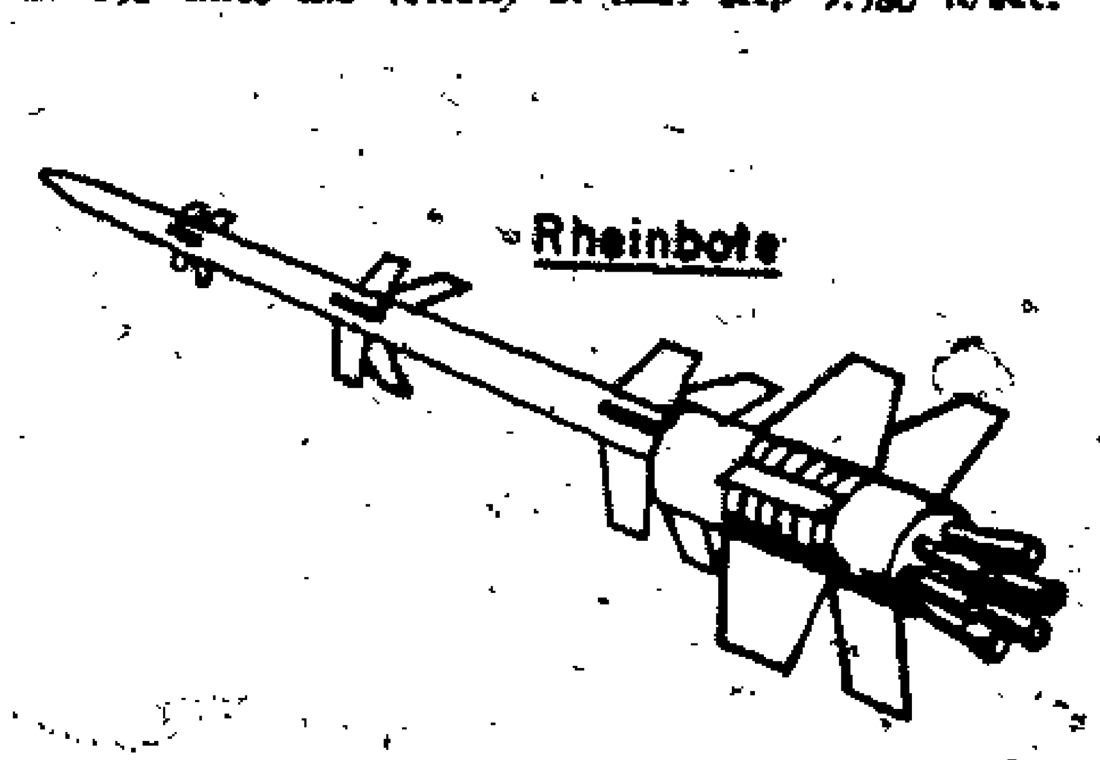
Resins. The thermoplastic and thermosetting resins used by the Germans during WW II are briefly discussed by B.Schools in BIOS Final Report 1191 (1946).

Revolver (Revolver). See under Weapons.

Rexit. See Rhexit.

RGP 89 (Rauchloses Geschützpulver 1889) (Smokeless Cannon Propellant of 1889). A propellant similar in composition to Italian Ballistite.
Reference: Daniel, Dictionnaire, Paris (1902), p 682.

Rheinbote (Rhein Messenger). An unguided, three-steps + booster, surface-to-surface missile, developed in 1943 by the Rheinmetall-Borsig Co under the direction of Klein and Vüllers. It contained 45 lb of HE, used 1287 lb of a solid diethyleneglycol dinitrate propellant, was provided with a six-finned booster, and could be launched from a stationary or mobile ramp. Total weight of rocket was 3,781.5 lb and overall length 37.4 ft. Diameters of the 1st and 2nd steps were 0.88 ft and of the 3rd step 0.53 ft. The lengths of the 1st and of the 2nd steps were 11.4 ft and of the 3rd 13.1 ft. Maximum range, when using 65° elevation was 136 miles and velocity at final step 5,380 ft/sec.



References:
1) K.W.Gatland, Development of the Guided Missile, "Flight" Publication, London, (1952), pp 55 & 122 3
2) W.Dornberger, V-2, Viking, N Y (1954), p 248.

Rheinisch Dynamit. A dynamite patented in 1874 consisted of NG (contg 2-3% of dissolved hydrocarbons such as napthalene) 75, washed and dried kieselguhr 23 and chalk 2%.
Reference: Daniel, Dictionnaire, Paris (1902), p 682.

Rheinmetall Ammunition. The Rheinmetall-Borsig Co was one of the principal manufacturers of ammunition. Some items manufd before WW II were examined at Picatinny Arsenal.
Reference: G.Taliaferro, Pic Arsn Tech Rept 982 (1939).

Rheintochter (Daughter of the Rhein). A type of guided missile used against England during WW II. Several models were known, such as R-1, R-2 and R-3.
References (See also under Guided Missiles):
1) Anon, Army Ordnance, 31, 28 (1946)
2) A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 89-90 and 96-98
3) Anon, TM 9-1985-2 (1953), pp 226-9.

Rhexit oder Rexit (Rhexite). According to Colver (Ref 1) Rexit was one of the earlier permissible explosives. It contained: Am nitrate 64 to 68, NG 6.5 to 8.5, TNT 6.5 to 8.5, Na nitrate 13 to 16, wood meal 3 to 5 and moisture 0.5 to 1.5%.

According to Naoum (Ref 2), Rhexit was one of the pre-WW II straight dynamites, such as: NG 64.0, wood meal 7.0, partly decomposed wood 11.0 and Na chloride 18.0%. Its properties were: density 1.54, Trauzl test value 385 cc, oxygen balance -11%, and Pb block crushing value 20 mm.
References:
1) Colver, High Explosives, London (1918), p 249
2) Naoum, Nitroglycerin, Baltimore (1928), pp 283-284.

Rhinoceros. See Nashorn, under Panzer.

Riegelmine. See under Landminen.

Rifle (Gewehr). See under Weapons.

Rifled Projectile (Pre-rifled Projectile). Three such projectiles were described in TM 9-1985-3 (1953), pp 526-528. All of them had a rifled design which took the form of 12 longitudinal splines inclined about 5° and spaced about 60 mm apart. The splines were not machined from the main projectile body but constructed separately on strips of steel which were then fitted into grooves cut in the projectile body. The grooves were undercut to provide secure attachment.

It is assumed that the splines were intended to engage in the rifling of the gun.

To the rear of the projectile there was a copper or bimetallic driving band, the probable function of which was to act as a gas seal.

Two of these projectiles were used in the Railroad Cannon 28 cm K 5 (E), while the use of the third projectile is unknown.

One of the projectiles [28 cm (280 mm)] was rocket-assisted. It weighed about 546 lb (loaded and fuzed, but without rocket ignition fuze). The weight of HE charge was about 31 lb and the wt of propellant 43 lb. The maximum range of the gun was about 53 miles.

Another type of 280 mm projectile weighed 562 lbs (loaded and fuzed) and was filled with about 67 lbs of TNT/Wax - 95/5, pressed in blocks in a cardboard container. (See drawings under Granate and under Rocket Assisted Shell).

(See also Pre-engraved and Pre-rifled Projectiles in the general section).

Rifle Grenades (Gewehrgranaten); Rifle Antitank Grenades (Gewehrpanzergranaten). The following types are briefly described in Refs 1, 2 & 3:

a) Small Antitank Rifle Grenade (Gewehrpanzergranate) was fired from the rifled 30 mm discharger cup (Schiessbecher), which could be fitted to most types of German rifles. The grenade was constructed in two parts, the head and the stem (body) which was screwed to the head. The head was a seamless steel tube, the forward portion of which contained a steel cone and the bursting charge consisting of 1.75 oz of TNT poured around the cone. Directly behind the TNT was located the PETN/wax exploder (auxiliary booster). The stem was made of a light alloy of aluminum and was provided with a pre-engraved driving band. The upper section contained the gaine (detonator-booster assembly), and the lower section the primer assembly. Total weight of the grenade was 8.8 oz, the overall length 6.4", the maximum diameter 1 3/16" and the range 50 yds (Ref 1, p 8 and Ref 2, pp 334-5)

b) Antitank Mauser Rifle Grenade, designated as C Pzgr 42, described in Ref 3a was similar in appearance to the one described immediately above. The C Pzgr 42 contained 49 g of 50/50 Cyclotol as the bursting charge. Its booster and auxiliary booster consisted of 91.4/8.6 PETN/Wax and weighed 12.7 g. The fuze assembly consisted of an upper primer charge of 0.018 g of K chlorate 62, Sb sulfide 30 and abrasive 8%, and a lower primer charge of 0.01 g of carbon. Its detonator contained 0.33 g of 76/36 - Lead azide/Lead styphnate (upper charge) and 0.49 g of PETN (lower charge) (See general Section under Carbon)
The grenade was propelled by a 1.0 g charge containing 96.5% NC (13% N), 0.6% diphenylamine and 0.1% graphite, the rest being organic impurities in NC, total volatiles and water soluble substances. The primer charge consisted of 0.028 g of a mixture of Ba nitrate 46, Pb styphnate 35, Ca silicide 15 and Sb sulfide 4%. Total weight of the grenade was 0.525 lb and the overall length 6.36" (Ref 3a)

c) Large Antitank Rifle Grenade (Grosse Gewerpanzergranate) was fired from the same 30 mm discharger cup (Schiessbecher) as the small grenade described under (a). The head of this grenade was larger (max diam 1¼"). The length of the ensemble (head and stem) was 7", the total weight 13½ oz and the wt of the filler (TNT) 4½ oz. Its range was 100 yd. The fuze and booster were similar to the grenade (a) (Ref 1, p 8 and Ref 2, pp 336-7)

d) Antitank Rifle Grenade (Schuss Gg P40) consisted of a streamlined bell-shaped body, with a slightly convex closing disc of aluminum, a graze fuze which screwed into the base of the body, and a vaned tail unit which screwed on the base of the fuze and was closed by a rubber plug. The bursting charge consisted of cast Cyclonite/Wax with a hemispherical cavity in the head. The cavity was fitted with an aluminum liner. The grenade was fired from a spigot type discharger using the 7.92 mm small type cartridge with a hollow wooden bullet. The propelling gases overcame the spring of the cutting piece (see drawing) and drove the pin forward causing it to cut the shearing pin away from its screwed end. The pin was then ejected (by the spring held in compression under its head) and thus left the striker which had been held away from the detonator only by the creep spring. On grazing impact the momentum of the striker overcame the tension of the creep spring and the detonator was pierced. The grenade assembly was 9.3" long, the head 3.1" and its maximum diameter 2.4" (Ref 1, p 9 and Ref 2 pp 337-8)

A more detailed description of the grenade is given in Ref 3c. The composition of the propellant was: NC (13% N) 96.5, diphenylamine 0.6, graphite 0.1, total volatiles 0.9 & organic impurities 1.7%, and of the percussion primer water soluble 0.2, Ba nitrate 46, Pb styphnate 35, Ca silicide 15 and Sb sulfide 4%. The weight of propellant 1.0 g and of primer charge 0.028 g. The bursting charge (34.1 g), consisting of PETN 88 and wax 12%, was initiated either by the friction igniter or by the detonator. The igniter contained as the upper charge 0.020 g of red lead 74.7, silicon 17.8 and binder & fuel 7.5%; as the intermediate charge 0.120 g of NC and as the lower charge 0.010 g of K perchlorate 55 and Pb ferrocyanide 45%. The delay element contained 0.090 g of black powder and the flash element consisted of 0.150 g of NC. The detonator contained as the upper layer 0.240 g of 68/32 - Pb azide/Pb styphnate, as the 1st intermediate layer 0.20 g of PETN, as the 2nd intermediate layer 0.120 g of Pb azide and as the lower layer 0.150 g of red lead 74.7, silicon 17.8 and binder & fuel 7.5%

e) 37 mm Antitank Rifle Grenade, fired from a 3.7 cm Pak, consisted of a thin-walled steel head of bulbous shape to which was attached a closed steel pipe surrounded by a multi-perforated sheet steel tube to which six vanes were welded. The head was loaded with 5.2 lb of either Dinitroaniline/TNT mixture or with pressed Cyclotol consisting of RDX 62.3, wax 2.4 and TNT 35.3%. Its nose fuze assembly (AZ 5075) consisted of a primer-detonator (with 0.31 g of lead azide as the upper charge and 0.30 g of PETN as lower charge) and a detonator-booster (with 0.50 g of 69/31 - Lead azide/Lead styphnate as the upper charge, 0.30 g of PETN as the lower charge and 6.8 g of 90/10 - PETN/Wax as the booster). Its base fuze assembly (BdZ 5130) consisted of a primer (containing 0.150 g of 41/30/20/9 - K chlorate/Sb sulfide/Mercury fulminate/Glass and a binder mixture, of 0.050 g of black powder consisting of 73/15/12 - K nitrate/charcoal/sulfur) and a detonator-booster (contg 0.50 g 69/31 - Lead azide/Lead styphnate, 0.30 g of PETN and 6.8 g of 90/10 - PETN/Wax). The propelling charge consisting of 217 g of NC/NG or NC/DEGDN tubular propellant was contained in a steel cartridge case. The charge was ignited by 4 g of NC granular propellant and a percussion type primer consisting of 41.7/25.5/20.5/12.3 - K chlorate/Mercury fulminate/Sb sulfide/Abrasive and 0.5 g of black powder (75.9/14.7/9.2 - K nitrate/Charcoal/Sulfur). The impact fuze functioned in the case of direct impact, whereas the base fuze functioned in the event of graze action. Total weight of the grenade was 18.7 lb, over-all length 12 1/8" and length of body 12 1/4" (Ref 2, pp 335-6)

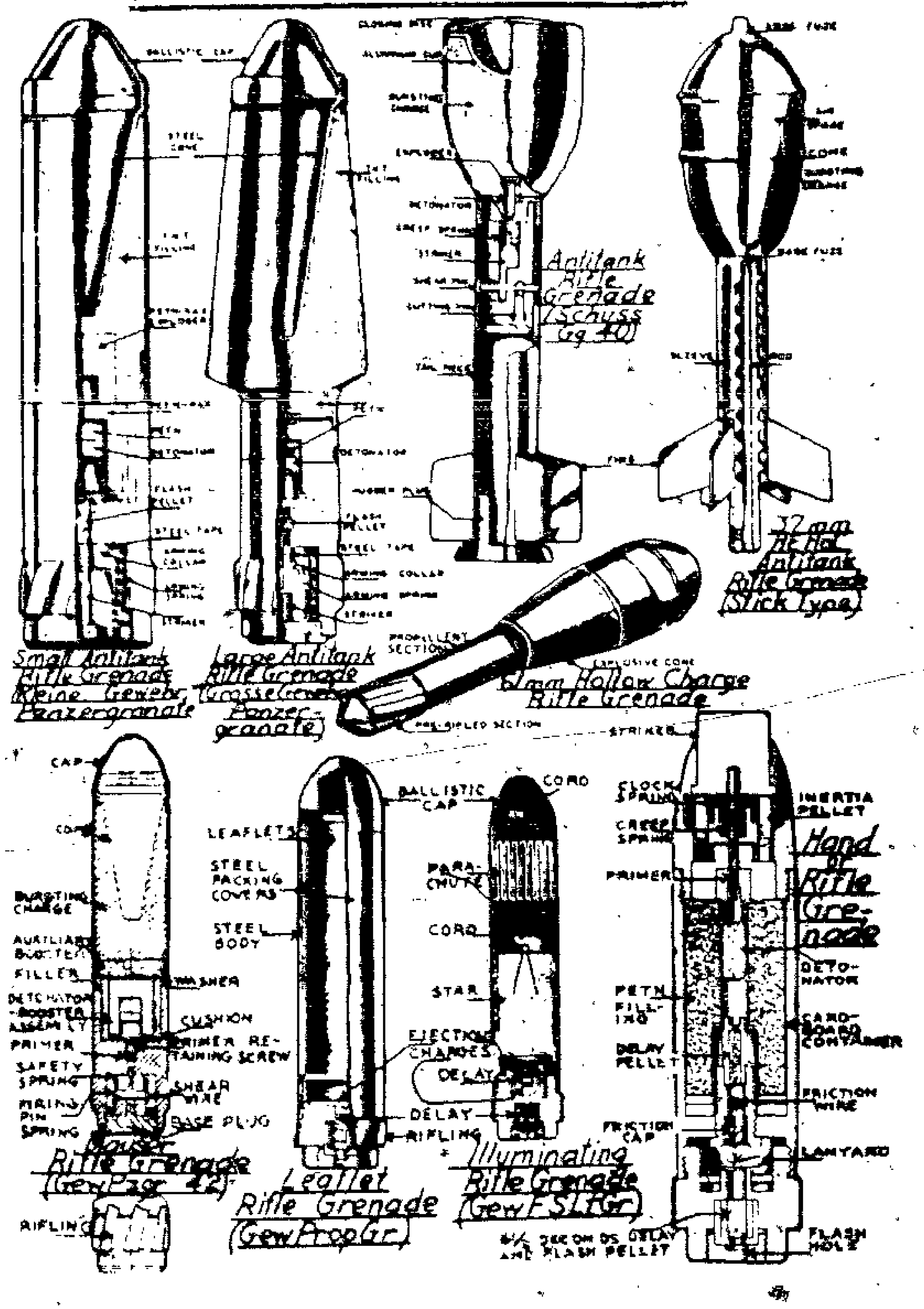
A more detailed description of the grenade is given in Ref 3b

f) Antipersonnel Rifle and Hand Grenade (Gewehrsprenggranate), fired from a Mauser Rifle Grenade Discharger, consisted of a cylindrical body (5.5" long and 1.2" max diameter) which contained a bursting charge, an igniter, delay elements and a detonator. A point-detonating (PD) fuze initiated the bursting charge when the grenade was fired from the discharger, and a friction igniter (similar to BZ 24) initiated a delay element (consisting of black powder pellet burning for 4½ seconds) when the grenade was thrown by hand. The grenade also had a self-destroying feature which functioned in case of failure of the PD fuze when fired from the discharger. Total weight of the of the missile was 9 oz and maximum range 550 yd. (Ref 2, pp 332-4)

g) 46 mm Antitank Rifle Grenade (SS Gewehrpanzergranate) consisted of a base-fuzed thin walled steel bulbous-shaped streamlined head (46 mm in diameter and 93 mm long), to which was attached a prerifled cylindrical stem 30 mm in diameter and 102 mm long. Its bursting hollow charge consisted of 143 g of 50/50 - RDX/TNT which was initiated by the following devices: a fuze primer (contg 0.068 g of K chlorate 49.8, Sb sulfide 43.0 and Hg fulminate 7.2%), a detonator (contg 0.33 g of 77/23 - Pb azide/Pb styphnate as the upper layer and 0.46 g of PETN as the lower layer), and a booster (contg 6.4 g of 94.5/4.5 - PETN/Wax mixture). It was propelled by 1.44 g of single-base propellant (contg 97.3 % of NC with a N content 13.2%) which was primed by 0.027 g of a mixture contg Ba nitrate 49.5, Pb styphnate 35.6 and Ca silicide 14.9%. The total weight of the grenade was 15½ oz and overall length 195 mm (Ref 1, p 9; Ref 2, p 331 and Ref 3e).

h) 61 mm Antitank Rifle Grenade (SS Gewehrpanzergranate). This grenade was similar in construction, except for some dimensions, to the previous grenade.

RIFLE GRENADES



The total weight was 19 oz, overall length 238 mm, length of stem 102 mm and its diameter 30 mm, length of head 136 mm and its max diameter of mm. Its bursting and propellent charges, as well as its primers, detonator and booster were the same as for the 46 mm grenade (Ref 1, p 9, Ref 2, p 331 and Ref 3d)

i) of mm Antitank Rifle Grenade, briefly described on p 332, Ref 2, was similar in construction to the previous grenade. Its overall length was 244 mm.

j) Leaflet Rifle Grenade (Gewehr Propagandagranate) was fired from the rifled 30 mm discharger cup (Schiessbecher) which could be fitted to most types of German rifles. It consisted of a cylindrical steel body (with a prerifled base) containing a delay fuze, a thin cylindrical container for the pamphlets and an ejecting charge for this cylinder. On firing the grenade, the propellent gases ignited the delay fuze and, after about 9 seconds of delay, the fuze fired the ejecting charge. The resulting deflagration blew off the cap and forced the leaflets out the nose. Total weight of grenade 8 oz, overall length 5.7" and range 500 yd (Ref 2, p 338)

k) Illuminating Parachute Rifle Grenade (Gewehr Fallschirmleuchtgranate) consisted of a thin-walled cylindrical body, within which was another container which housed the parachute and illuminating star. The rear of grenade contained two delay pellets and two ejection charges. When fired the flash from the propellent gases ignited delay (1), and after 6.5 sec of flight ejection charge (1) was initiated. The pressure of the gases forced out the nose, the container (which held the parachute) and the star. At the same time, delay (2) was ignited and after it burned through (2 seconds) the ejection charge (2) became initiated. The resulting gases ejected the parachute and the star from the container and ignited the star. It was claimed that distances up to 650 meters could be illuminated by this star. (Ref 2, p 339)

(See also Faustpatrone and Pistol Grenades).

References:

1) A.J.Dere, The Ordnance Sergeant, October 1945, pp 8-10;
2) Anon, TM 9-1985-2 (1953), pp 331-39
3) Picatinny Arsenal Technical Reports:
a) A.B.Schilling, No 1342 (1944)
b) A.B.Schilling, No 1398 (1944)
c) A.B.Schilling, No 1494 (1945)
d) F.G.Haverlak, No 1507 (1945)
e) F.G.Haverlak, No 1509 (1945).

Rifle (Gewehr). See under Weapons.

Rifling of Weapons. See general section.

RLGS (Raketenleuchtgerät Scheingeschoss). Rocket Illuminant Simulating Device. See under Pyrotechnic Antipathfinder Devices and also in CIOS Rept 32-56 (1945), p 21.

R-Mine 43. See under Landminen and also in TM 9-1985-2 (1953), p 272.

Roburit (Roburite). A type of permissible explosive patented by Roth about 1886. The earliest type consisted of Am nitrate 90 and dinitrochlorobenzene 10%. It was claimed by the inventor that a nitrated chloro-compound gave a higher velocity of detonation and greater power than the corresponding nitro-hydrocarbon. The above Roburite was sensitive to friction; when ignited with a flame or a spark it burned without exploding.

Table 52 gives the composition and some properties of several Roburites

(See next column).

References:

1) J.Daniel, Dictionnaire des Matières Explosives, Paris (1902), p 687
2) Marshall, v 1 (1917), p 391
3) Colver (1918), p 141.

Table 52
Roburites

Components and Some Properties	Designation I	II	III
Am nitrate	87.5	71.5	55.0
K nitrate	-	5.0	9.5
K permanganate	0.5	0.5	0.5
Am sulfate	5.0	-	-
m - DNB	7.0	-	-
TNT	-	12.0	12.0
Flour	-	6.0	6.0
Na chloride	-	5.0	7.0
Am chloride	-	-	5.0
Magnesite	-	-	5.0
Trauzl Test, cc	-	325	257

Röchling Anticoncrete Projectile (Röchlinggranate 42 Beton, abbreviated as RöGr 42 Be). According to German photographs available at the Picatinny Arsenal and Aberdeen Proving Ground Museums, it was a subcaliber shell which resembled in appearance the "arrow projectile", except that instead of the fin assembly of the arrow shell it had a discarding flange serving as a driving band. The front flange acted as bourrelet. These projectiles were fired from regular guns, such as caliber 21 cm and 34 cm. The 21 cm shell weighed 193 kg and was 2.1 m long. The corresponding characteristics for the 34 cm shell were: 913 kg and 3.7 m.

RÖCHLING PROJECTILES

The shells were designed and manufactured by the firm of Röchling at Saarbrücken, Saar.

References:

1) K.F.Kempf, Museum of Aberdeen Proving Ground, Md; private communication
2) H.H.Bullock and G.Coghlan, Picatinny Arsenal Museum; private communication.

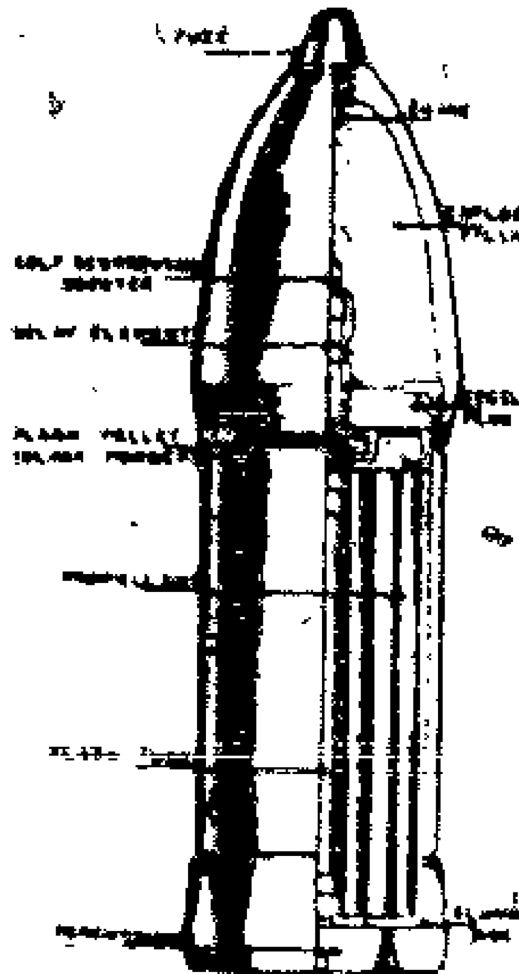
(See also Arrow Projectiles and Gessner Projectiles).

Rocket (Rakete). German rockets of WW II were propelled either by solid propellants (such as colloided smokeless double-base NC-NG propellants) or by liquid propellants. The liquid propellants consisted of combustibles (such as alcohol, benzene, aniline, gasoline etc) and oxygen carriers, such as liquid oxygen, hydrogen peroxide, nitrogen peroxide, nitric acid, etc. (See under Rocket Propellants).

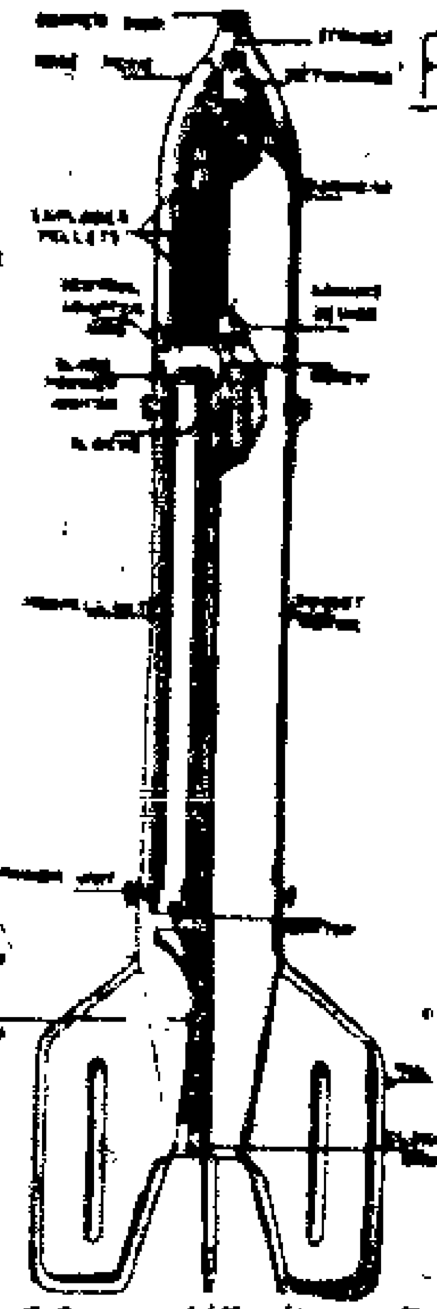
The following rockets were briefly described in Ref 3. (Some information on these rockets may be found in Refs 1 and 2).

a) Butterfly (Schmetterling) Rocket Hs117 (Hs297) (Ref 3, p 196) (See under Guided Missiles)

ROCKETS

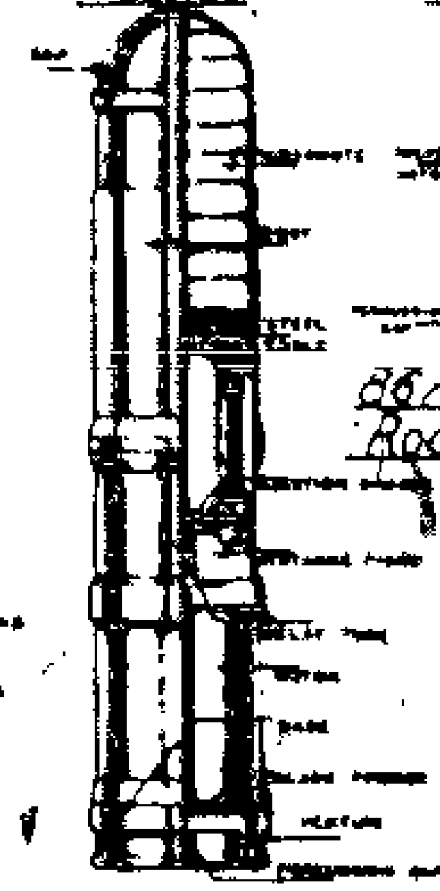


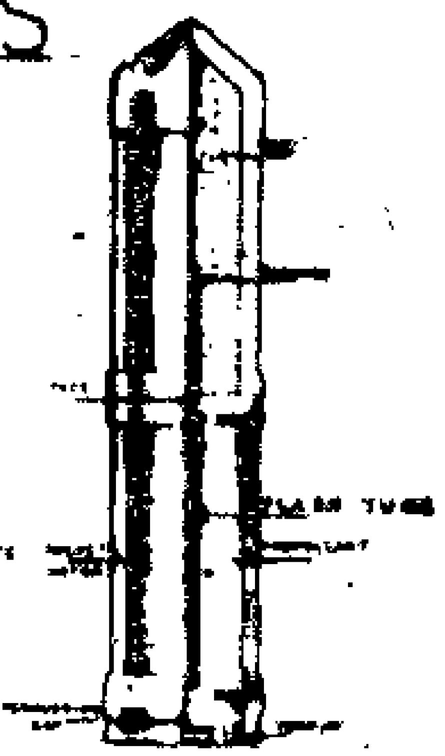
73 mm HE Rocket (7.3 cm R.Sprgr)



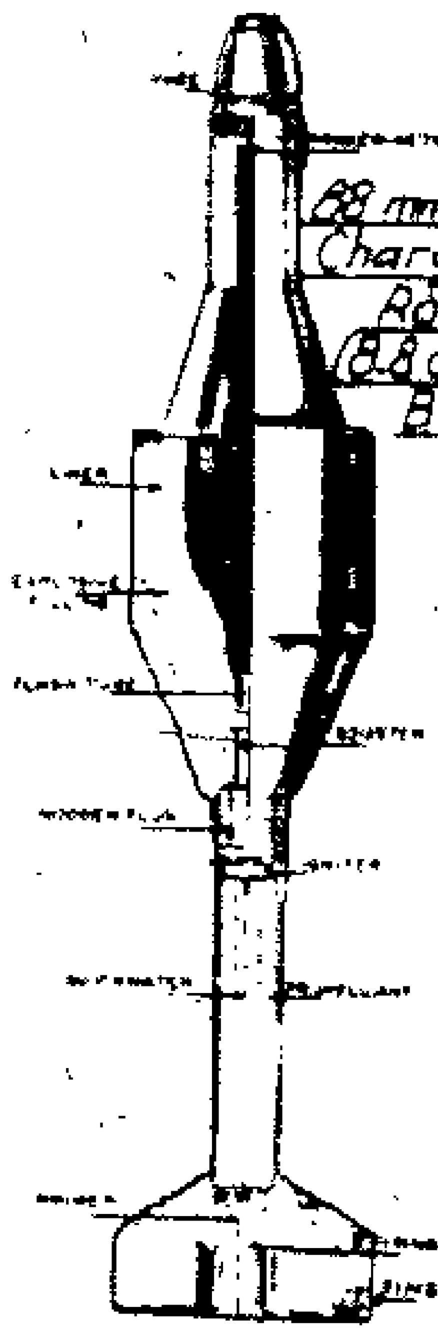
86 mm HE Aircraft Rocket (8.6 cm R.Sprgr)

86 mm Naval Antiaircraft Rocket

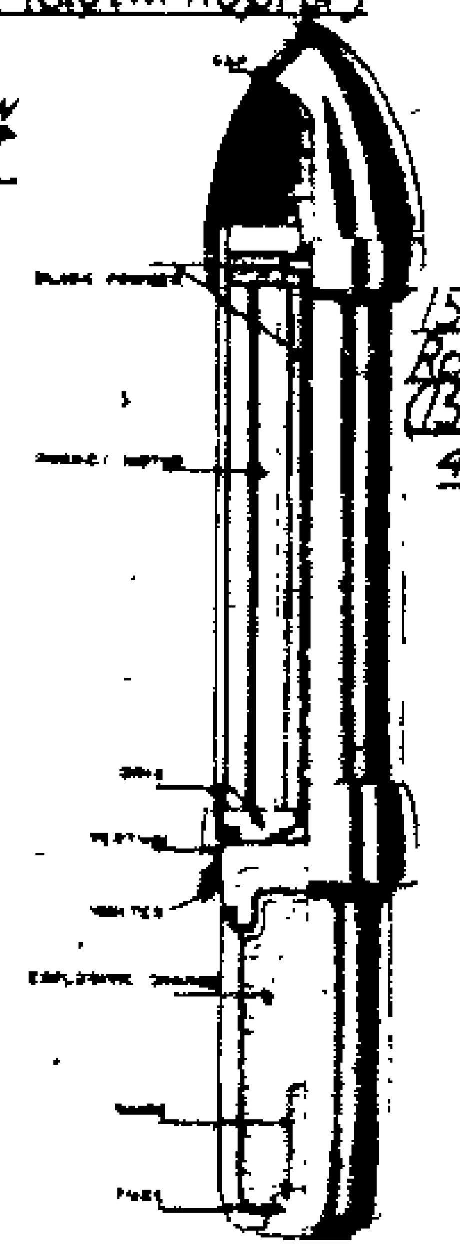




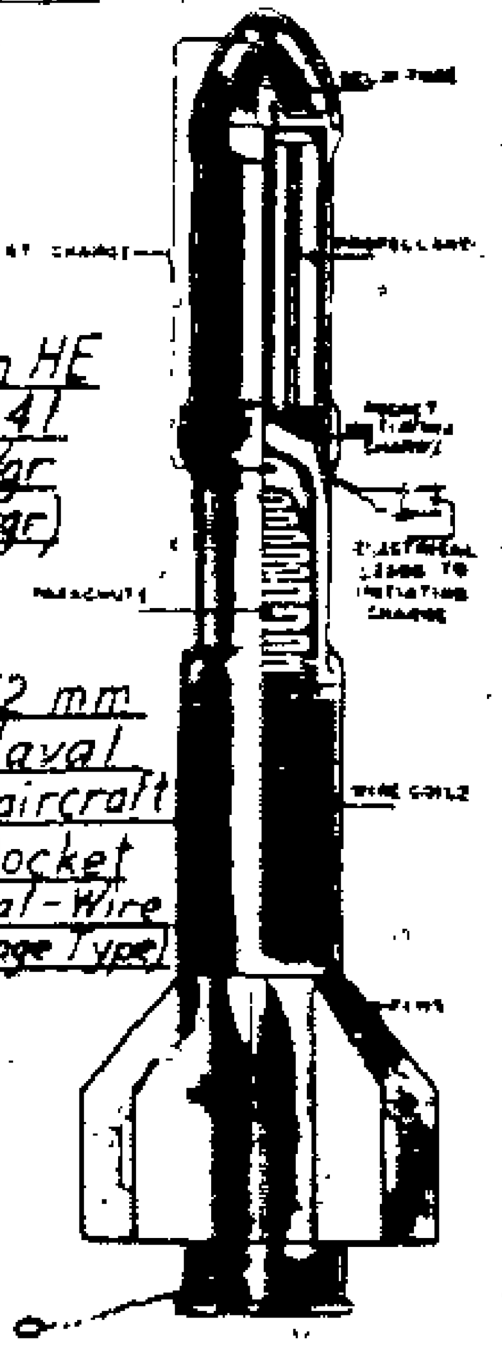
86 mm Naval HE Rocket (8.6 cm R.Sprgr.Wsm)



88 mm Hollow Charge A/T Rocket (8.8 cm R.Pz.B.Gr)

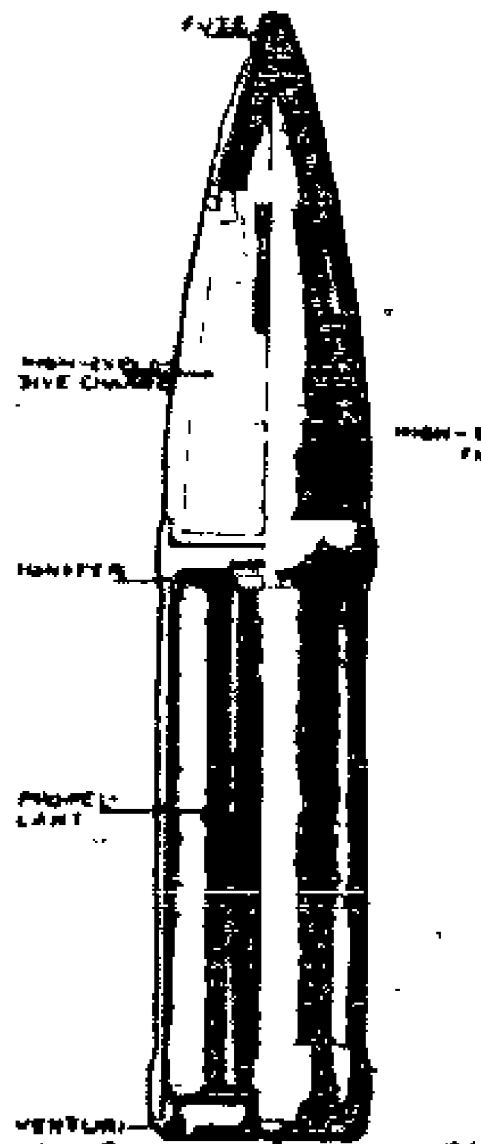


150 mm HE Rocket 41 (15 cm Wgr 41 Sprgr)

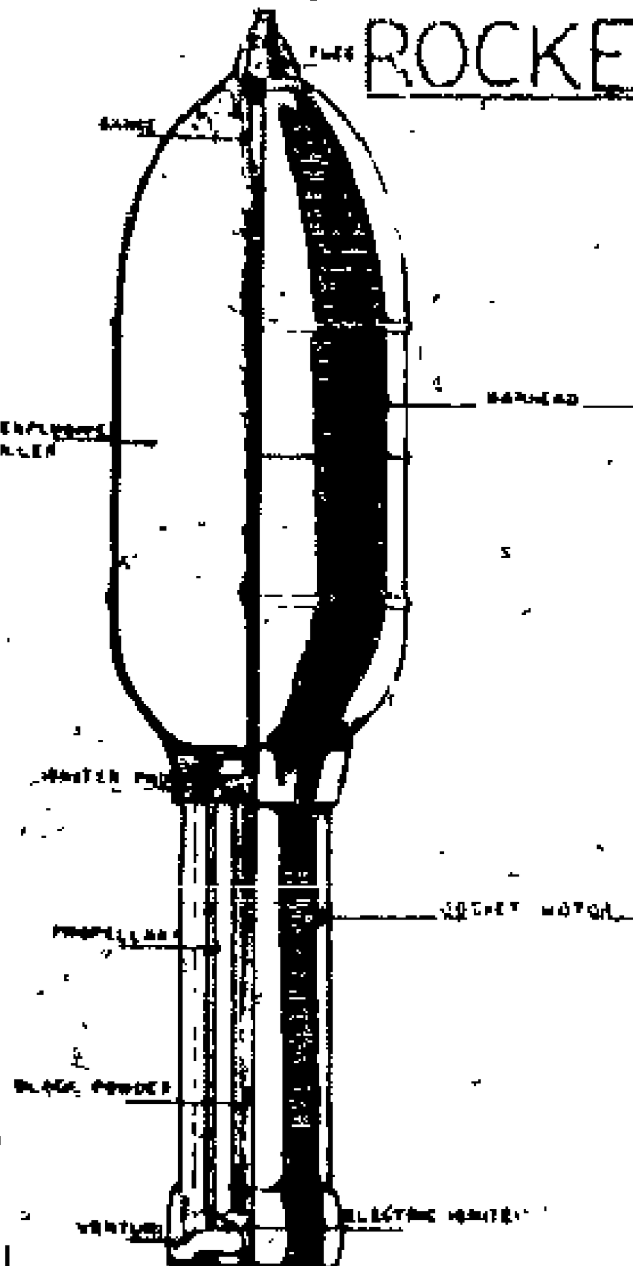


152 mm Naval Antiaircraft Rocket (Aerial-Wire Barrage Type)

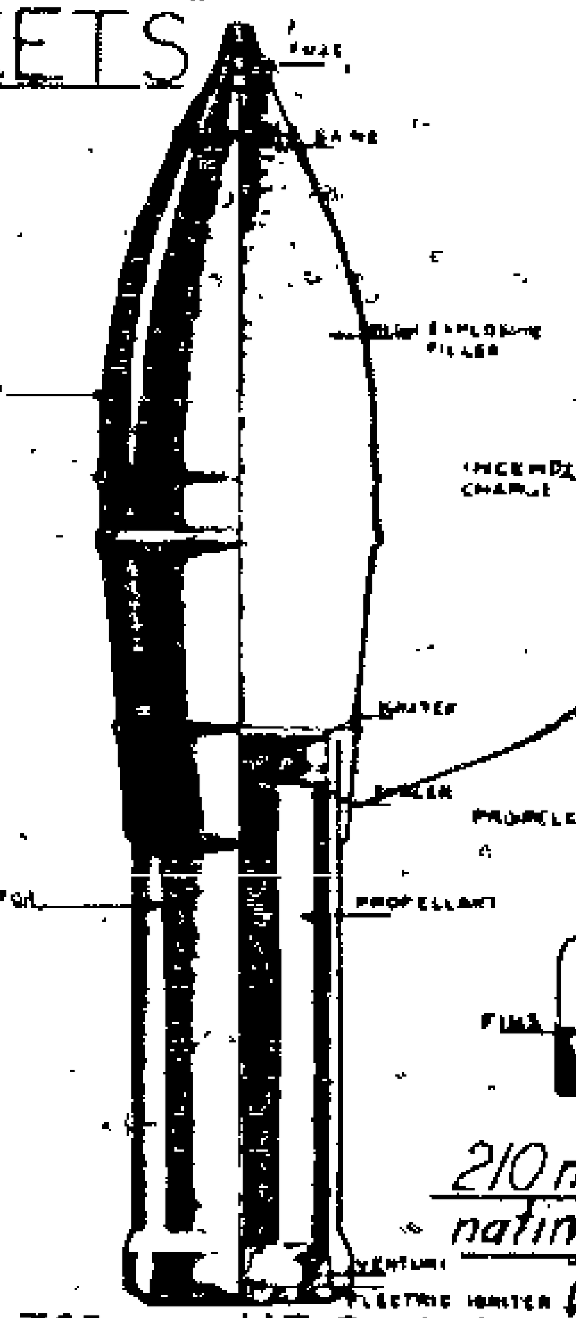
ROCKETS



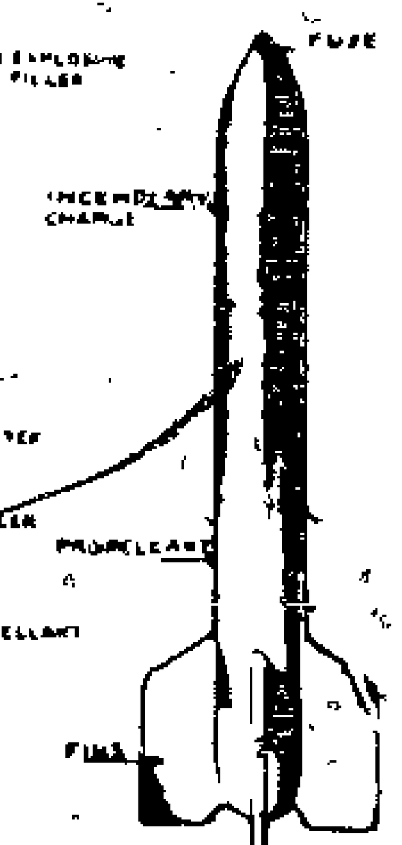
210 mm Aircraft Rocket (21 cm Wgr 42 Spr)



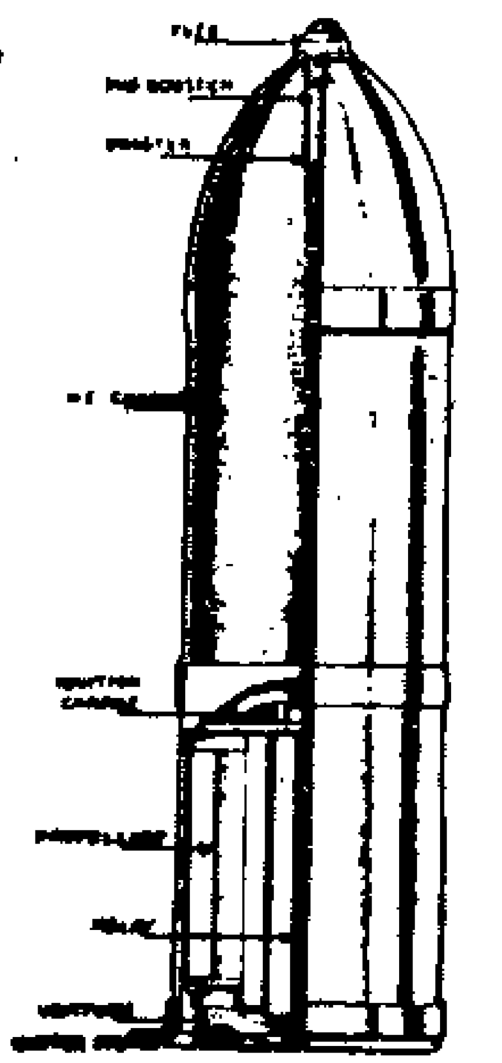
280 mm HE Rocket (28 cm Wfk Spr)



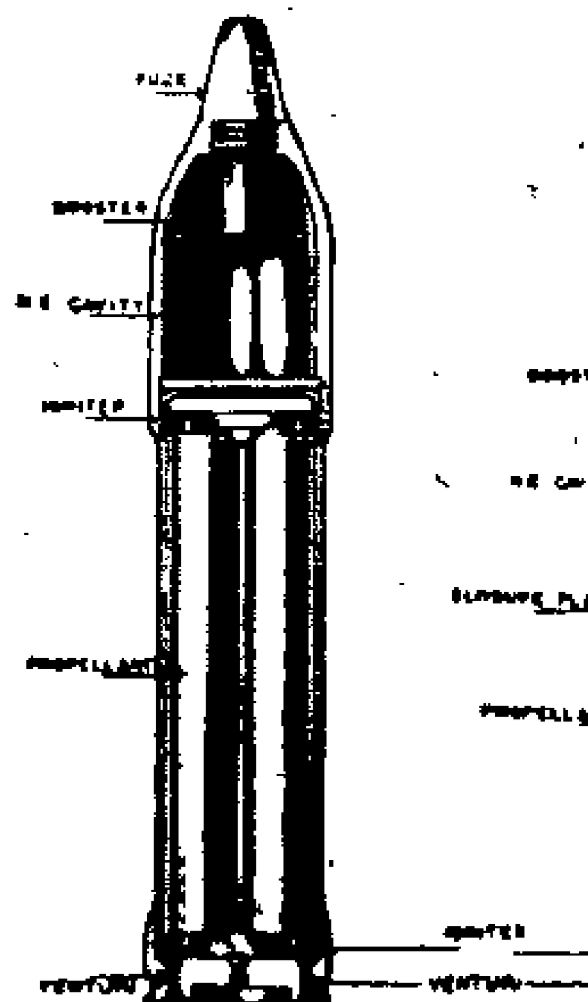
300 mm HE Rocket (30 cm Wfk 42 Spr)



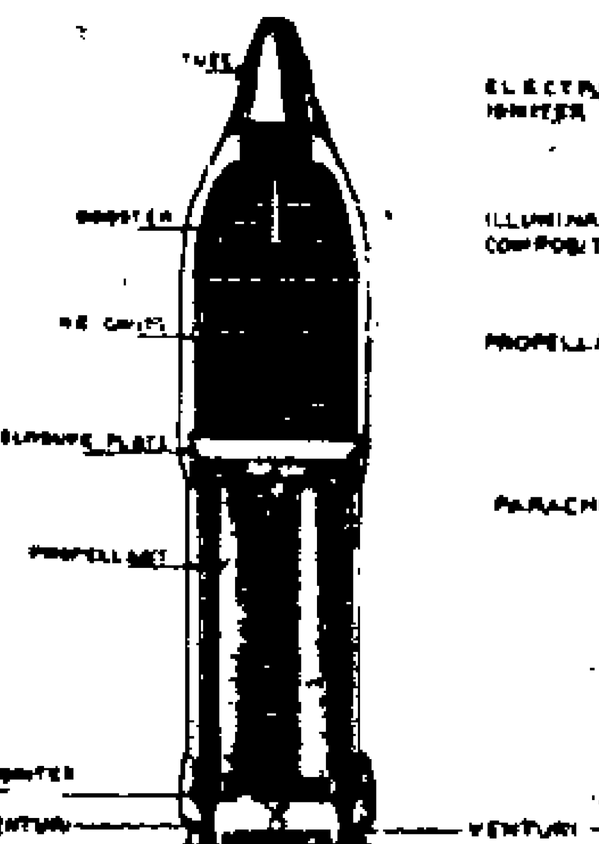
210 mm Illuminating Rocket (R 100 BS)



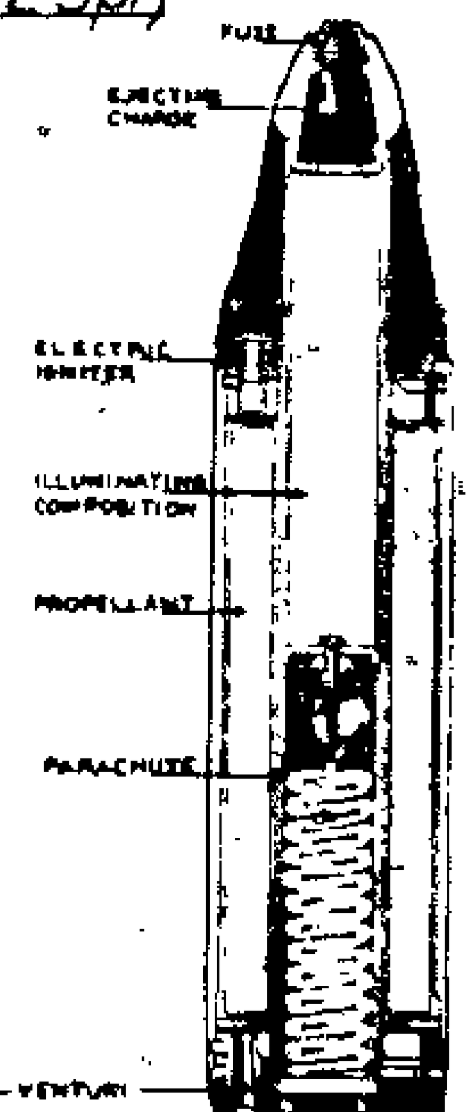
380 mm HE Rocket (38 cm R.Sprgr 4581)



86 mm HE Rocket (8.6 cm R.Sprgr L/5.5)



86 mm HE Rocket (8.6 cm R.Sprgr L/4.5)



210 mm Illuminating Rocket (2.1 cm R.Lg)

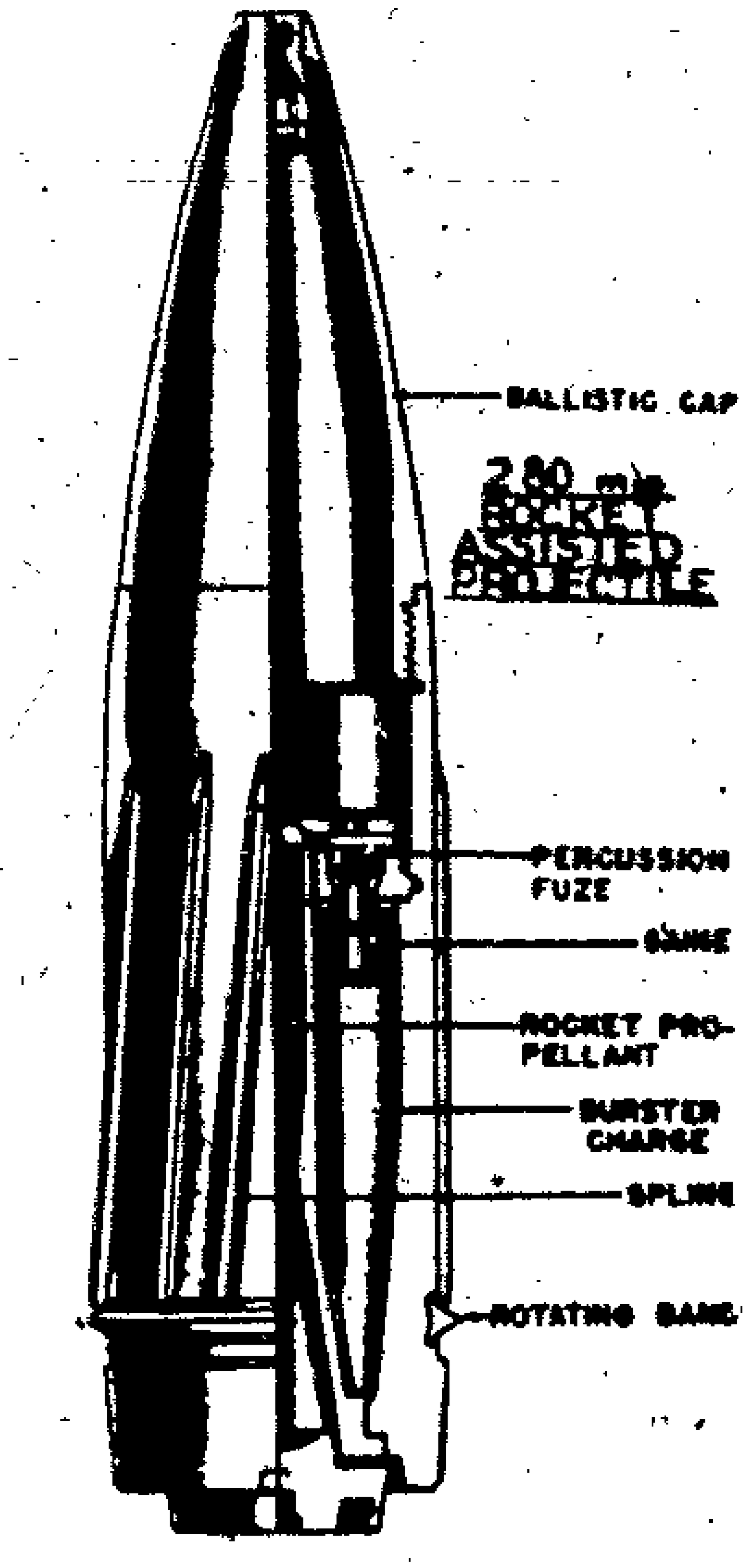
b) Daughter of the Rhine (Rheintochter) Rocket (Ref 3, p 226)
c) Fire Lily (Feuerlilie) Rockets F-25 and F-55 (Ref 3, p 224)
d) Great Enzian Rocket (Ref 3, p 229)
e) Henschel Rockets Hs293 and Hs298 (Ref 3, p 200)
f) Long Range Rockets A-9 and A-10 (Ref 3, p 235)
g) Radio-Controlled Glider Bomb PC 1400 FX (Ref 3, p 195)
h) Rockets V-1 and V-2 (Ref 3, p 205)
i) Rocket X-4 (Ref 3, p 214)
j) Taifun Rocket (biliquid) (Ref 3, p 225)
k) Waterfall (Wasserfall) Rocket C-2 (Ref 3, p 219)
l) 73 mm Propaganda Rocket (7.3 cm Propagandagranate) (Ref 3, p 234) and 73 mm HE Rocket Shell (7.3 cm Raketensprenggranate) (Ref 3, p 235)
m) 80 mm HE Rocket Shell (8 cm Raketensprenggranate) (Ref 3, p 237)
n) 86 mm HE Rocket Shell (8.6 cm Raketensprenggranate) (Ref 3, p 239), 86 mm R Sprgr L/4.5 Rocket (Ref 3, p 256), 86 mm Illuminating Rocket (Naval) (Ref 3, p 240) and 86 mm Antiaircraft Rocket (Naval) (Ref 3, p 241)
o) 88 mm HoC, A/T Rocket (shaped charge antitank) (Ref 3, p 242)
p) 150 mm HE Rocket (spin-stabilized) (Ref 3, p 245) and 150 mm Smoke and Chemical Rocket (spin-stabilized) (Ref 3, p 245)
r) 152 mm Antiaircraft Rocket (fin-stabilized) (Ref 3, p 247)
s) 200 mm Antiaircraft Rocket (fin-stabilized) (Ref 3, p 248)
t) 210 mm HE Aircraft Rocket (spin-stabilized) (Ref 3, p 248) and 210 mm Illuminating Rocket R-Lg (Ref 3, p 258)
u) 280 mm HE Rocket (spin-stabilized) (Ref 3, p 250)
v) 300 mm HE Rocket (spin-stabilized) (Ref 3, p 251)
w) 320 mm Incendiary Rocket (spin-stabilized) (Ref 3, p 253)
x) 380 mm HE Rocket (spin-stabilized) (Ref 3, p 254)
y) R 100 BS Air-to-Air Rocket (Ref 3, p 255)

Abbreviations: HE High explosive; HoC Hollow charge (See also Guided Missiles).

References:

1) A.Ducrocq, Les Armes Secrètes Allemandes, Berger-Levrault, Paris (1947), pp 140-149
2) A.Stettbacher, Spreng- und Schiessstoffe, Rascher, Zürich (1948), pp 50-57
3) Dept of the Army Tech Manual TM 9-1985-2, (1953) pp 195-260
4) J.G.Tschinkel, Chem Eng News 32, 2582-2587 (1954)
The following Picatinny Arsenal Technical Reports were devoted to German rockets:
5) A.B.Schilling, Pic Arsn Tech Rept 1427 (1944), 90 mm Bazooka type rocket
6) A.B.Schilling, ibid 1568 (1945), Warhead and Fuzes of A-4 Rocket (Called also V-2 Rocket)
7) V.Lindner, ibid 1817 (1951), Evaluation of Some Rocket Propellants Used in WW II (Confidential).
Note: None of the confidential reports were used as sources of information for this work.
The following CIOS Reports contain some information on German rockets:
8) Gollin, CIOS 28-56 (1945), Rockets and Guided Missiles. (Included is the article of Dr W. von Braun, Survey of Development of Liquid Propellant Rockets in Germany)
9) F.G.Ewing & M.M.Mills, CIOS 29-45 (1945), Luftfahrtforschungsanstalt Hermann Göring (Rockets)
10) R.C.Still, CIOS 30-115 (1945), Rocket Power Plants Designed and Constructed by Walter Werke, Kiel
11) F.J.Ewing & M.M.Mills, CIOS 31-13 (1945), Ramjet and Rocket Works Heerte
12) H.J.Eppig, CIOS 32-56 (1945), Pyrotechnic Antipathfinder Devices (Includes description of pyrotechnic rockets: 15 cm RSSG, 15 cm RLGS and 15 cm Smoke Rocket)
13) A.B.Meinel, CIOS 32-114 (1945), 21 cm RLG Rocket (Flare).

Rocket-Assisted Shell. A projectile which contained a rocket propellant in a special device attached to the base of the shell was developed and used during WW II. The shell was fired in a regular manner from an 8 inch gun, but during the flight the rocket composition became ignited and the shell started to function as a rocket. This method of propulsion increased the range of the shell from 38 to 60 miles without appreciable increase of dispersion. Reference: PB Rept 925 (1945), p 19.



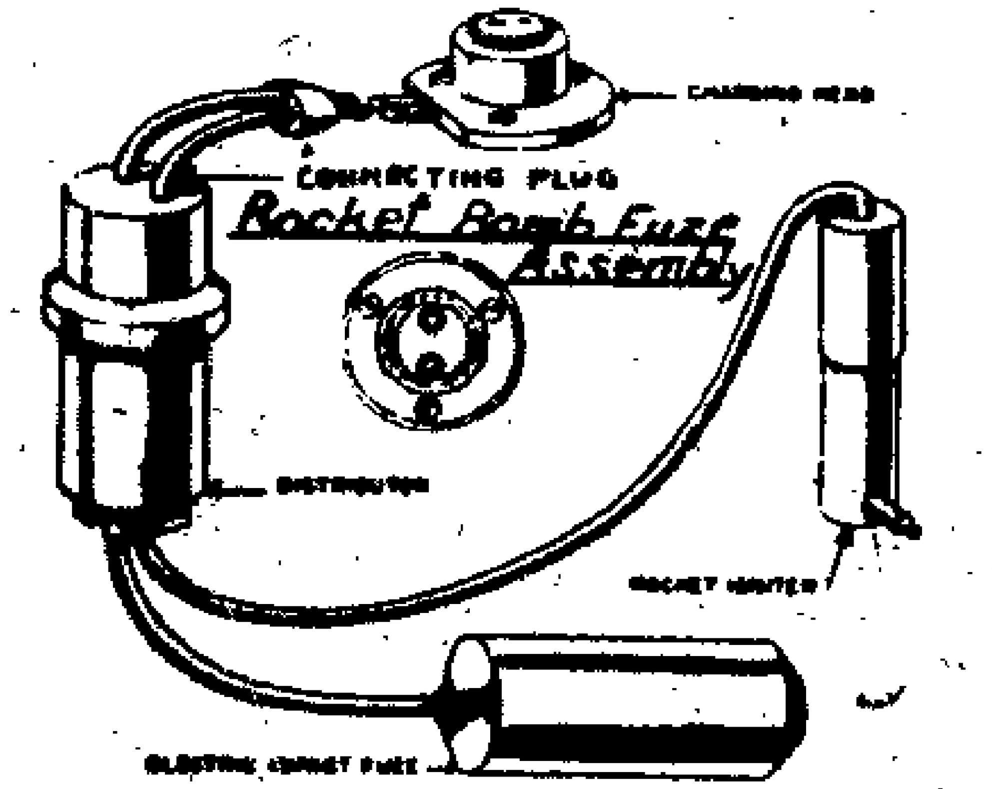
The following rocket-assisted projectiles are briefly described in TM 9-1985-3 (1953), pp 309-10 and 327-8:
a) 150 mm Projectile (15 cm RGr 19) weighed 99.5 lb and was fired from the Heavy Field Howitzer 18 (15 cm

sFH 18). Its cartridge case (semi-fixed) contained 13.64 lb of tubular, diethyleneglycol dinitrate type propellant
b) 280 mm Projectile (28 cm RGr 4331) weighed (without rocket ignition fuze) 546¾ lb and was fired from the Railway Gun [28 cm K 5(E)]. Its propellant charge was 43 lb of double-base propellant, and the bursting charge was 30½ lb of unknown HE. The shell was provided with a rocket ignition fuze (ZtZ S/30) which functioned after 19 seconds to ignite the rocket propellant and with two fuzes (AZ 4331) and two PETN boosters (ZZdlg C/98Np) which initiated the bursting charge on impact
c) In CIOS Rept 30-115 (1945), pp 26-27 and enclosure 20 are briefly described the Rocket Assisted Take-Off Units, designated as RI 203 and RI 209.

The following unclassified Picatinny Arsenal Technical Reports describe some rocket-assisted shells which were examined during WW II.

1) A.B.Schilling, 1604 (1946), 105 mm Rocket-Assisted, HE
2) A.B.Schilling, 1605 (1946), 105 mm Rocket-Assisted, HE
3) A.B.Schilling, 1606 (1946), 128 mm Rocket-Assisted, HE
4) A.B.Schilling, 1607 (1946), 150 mm Rocket-Assisted, HE
5) A.B.Schilling, 1608 (1946), 150 mm Rocket-Assisted, HE
6) A.B.Schilling, 1609 (1946), 150 mm Rocket-Assisted, HE
7) A.B.Schilling, 1610 (1946), 150 mm Rocket-Assisted, AP.

Rocket Bomb Fuze Assembly, described on pp 169-71 of TM 9-1985-2 (1953) operated as follows: On release from the aircraft the electric charge passed from the charging head to the distributor and thence directly to the bomb fuze. Then, after a delay the current passed to the



rocket propellant igniter. During the flight, the rocket was ignited and when the bomb hit the target the impact initiated the fuze. After a short delay (for penetration purposes) the bursting charge was detonated.

Rocket Bullet. According to CIOS Rept 33-20 (1946), pp 6, 6A & 7, a 9 mm rocket missile was under development during WW II by the Deutsche Waffen- und Munitionsfabriken A-G, Lübeck. A drawing is enclosed in CIOS Rept 33-20 but no description given.

Rocket Launcher or Projector (Raketenwurfmaschine oder Wurfgerät). According to the Intelligence Bulletin, War Department, Washington, D C, vol 3, No 7, March 1945, pp 1-9, the first German rocket launchers were Schweres Wurfgerät 40 (heavy throwing apparatus 40) and Schweres Wurfgerät 41. Each of them could fire either 280 mm or 320 mm rockets weighing 180 and 196 lb respectively. The 300 mm HE rocket also could be fired from these launchers.

The SWG 40 launcher consisted of a wooden frame (Wurfgestell 40) on which were placed wooden shipping crates containing rockets. The frame was inclined at the desired angle and the rockets were fired directly from the crates.

The SWG 41 launcher consisted of a frame of steel tubing (Wurfgestell 41) on which could be placed either wooden or steel shipping crates containing rockets.

The so-called Schweres Wurfrahmen 40 (heavy throwing rack 40) consisted of six inclined plates mounted on the sides of an armored half truck (three on each side). The rocket carrying crates were secured to the plates, and the latter then inclined at the required angle of firing.

One of the most important rocket projectors was the 15 cm Nebelwerfer 41 (literally "smoke thrower"), nicknamed by the U S soldiers "Screaming Meemie". It consisted of six grooved tubes, 5.9" in diameter, mounted on a light two-wheeled carriage with a split trail. The crew of two men loaded the weapon, took shelter in a slit trench and then discharged the rockets (a six-round salvo each 8 minutes) by remote control. The maximum range of these rockets was 8,000 yd.

Similar to the 15 cm Nebelwerfer 41 was the five-tube 21 cm Nebelwerfer 42 which fired 8 inch rockets as far as 8,600 yd.

Note: None of the Nebelwerfers were accurate and for this reason they were not very suitable for launching HE rockets. Besides using these launchers for rockets to lay down smoke concentrations, they were also suitable as projectors for gas-loaded (chemical) rockets. In both cases no accuracy of fire was required.

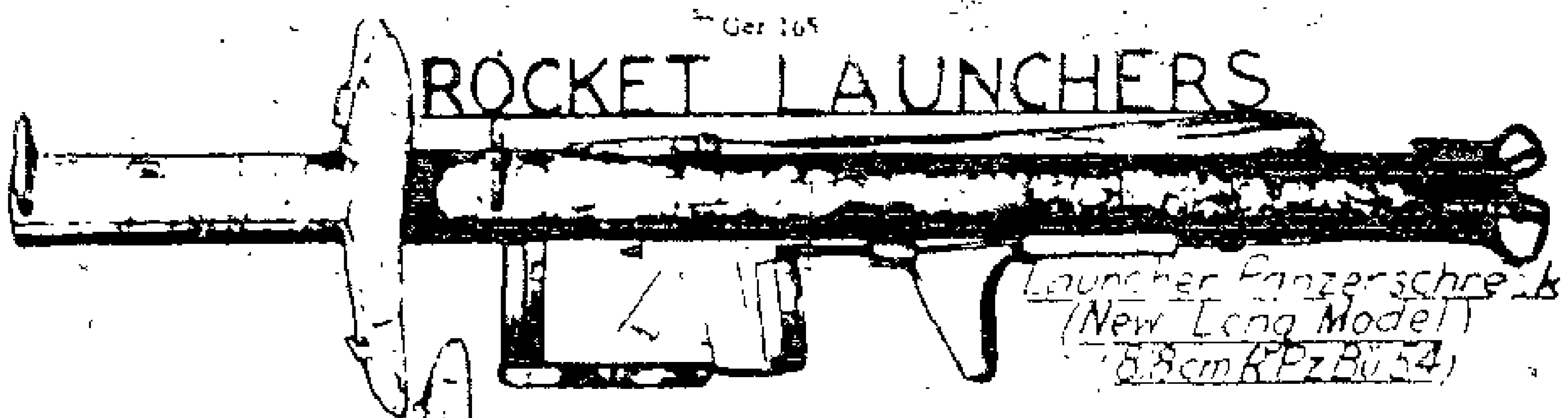
In order to give their larger rocket projectors greater mobility and speed of fire, and to increase the accuracy of fire of the rockets the Germans mounted the steel frames of the Wurfgerät 41 on two-wheeled carriages with pneumatic tires. The resulting weapons were called 28/32 cm Nebelwerfer 41 and 30 cm Nebelwerfer 42. The steel shipping crates containing rockets were inserted in the frames and then, when ready to fire, the crew (seven men per each launcher) took cover in two slit trenches to the rear of the right side of the weapon and one of the men fired a six-round salvo by remote control. It took about 5 minutes to reload the weapon. The maximum range for the 280 mm HE rocket was only 2,100 yd and for the 320 mm incendiary rocket 2,400 yd. The range for the 300 mm rocket is not given.

Dissatisfied with the slow rate of fire of the above launchers, the Germans in 1942 introduced a quicker firing weapon called the 15 cm Panzerwerfer 42 (150 mm antitank thrower 42). It consisted of two banks of 15 cm Nebelwerfer 41 launching tubes (with six tubes in each bank) mounted on an armored half-track. Since the crew did not need to dig slit trenches, but could take cover in the vehicle instead, the rockets could be fired somewhat faster than from the Nebelwerfer 41.

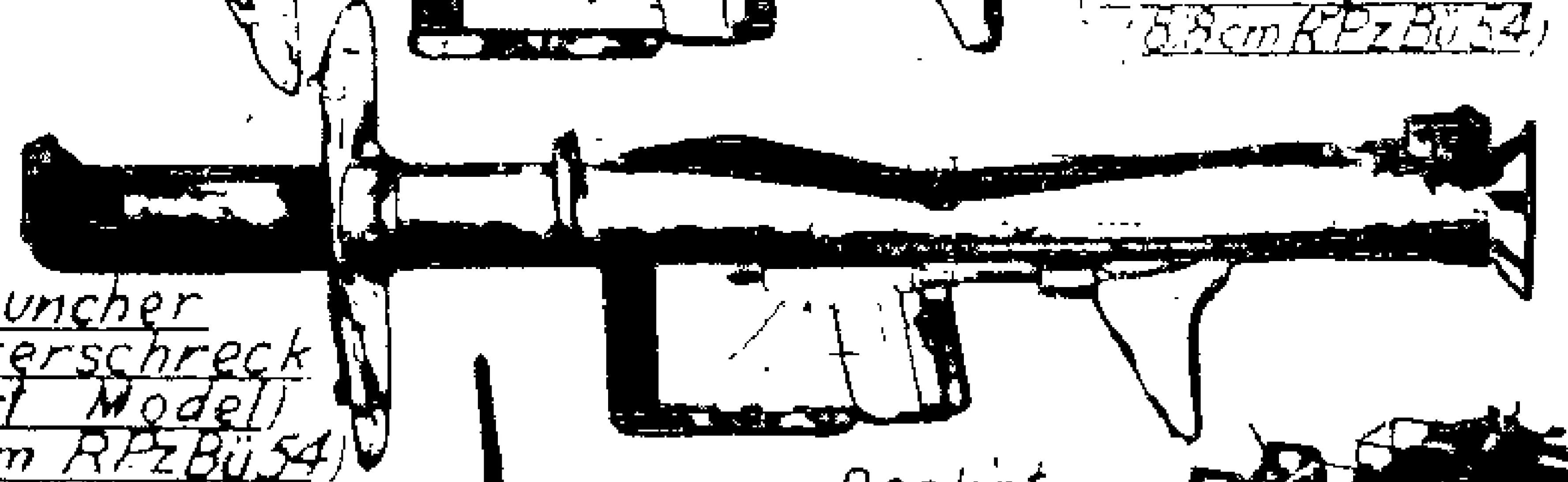
According to TM 9-1985-2 (1953), p 195, multibarrel projectors carrying up to 42 rocket rounds were developed by the Germans to effect a greater rate of fire. Reloading of these projectors was carried out mechanically.

The same TM 9-1985-2 mentions or briefly describes the following rocket launchers used during WW II:
a) A two-armed cradle type launcher for the Hs 117 (Hs 297) Schmetterling rocket-propelled missile (p 201)
b) A rail type launcher, 60 cm long (hung on the carrier aircraft) for the Hs 298 missile (p 205)
c) An inclined ramp type launcher used for the Feuerlilie F-55 rocket-propelled guided missile (p 225)
d) A launcher for the Great Enzian rocket consisted of two iron rails 6.8 m long mounted on a standard 88 mm gun carriage (p 229)
e) A single-tube type launcher (Propagandawerfer) for 7.3 cm Raketengranate 41 (p 234)
f) A 35-frame launcher (Föhngerät) for 7.3 cm Raketensprenggranate (p 235)
g) A multiple-frame ground launcher (Raketen Vielfachwerfer) for 8 cm Raketensprenggranate (p 237)
h) A single-barreled launcher, designated as 8.6 cm R Ag M42, for the 86 mm flare rocket (R Lg 1000) or wire rocket (RDg 1000) (p 240)
i) A single tube, two-wheel launcher (8.8 cm Raketenwerfer 43) for the 88 mm hollow charge rocket, designated as 8.8 cm R PzBGr 4312 (Raketen Panzerbuchse Granate) (p 245)
j) A single-barreled launcher designated as 21 cm R Ag M42, with a barrel 1.12 m in length, used for the 210 mm rocket designated 21 cm RLg (p 259)

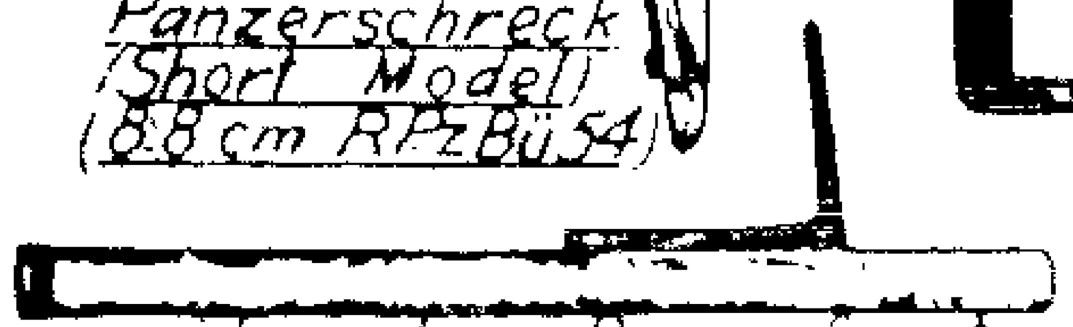
ROCKET LAUNCHERS



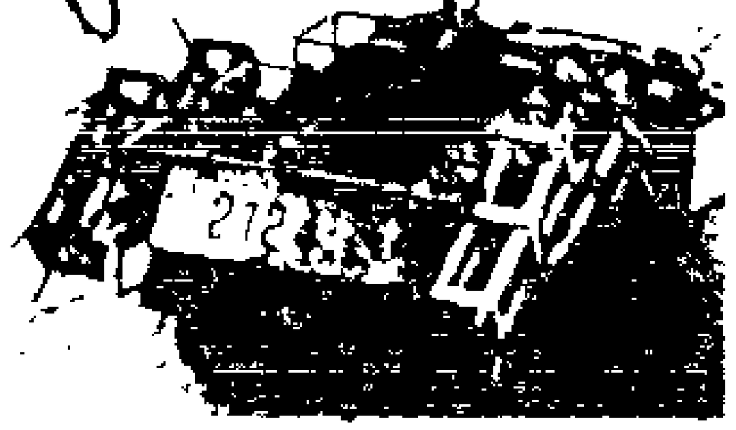
Launcher Panzerschreck (New Long Model) (8.8cm RPzBü 54)



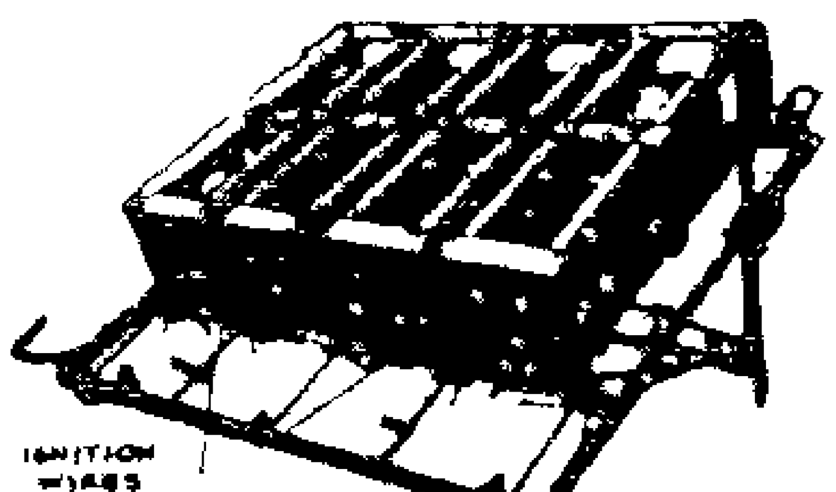
Launcher Panzerschreck (Short Model) (8.8 cm RPzBü 54)



Launcher Panzerfaust

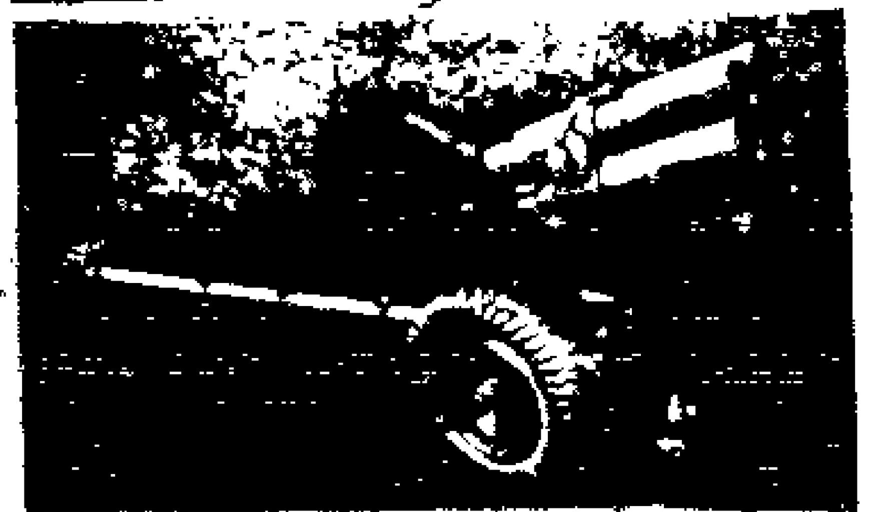


Rocket Launcher (Wurfrahmen 40)



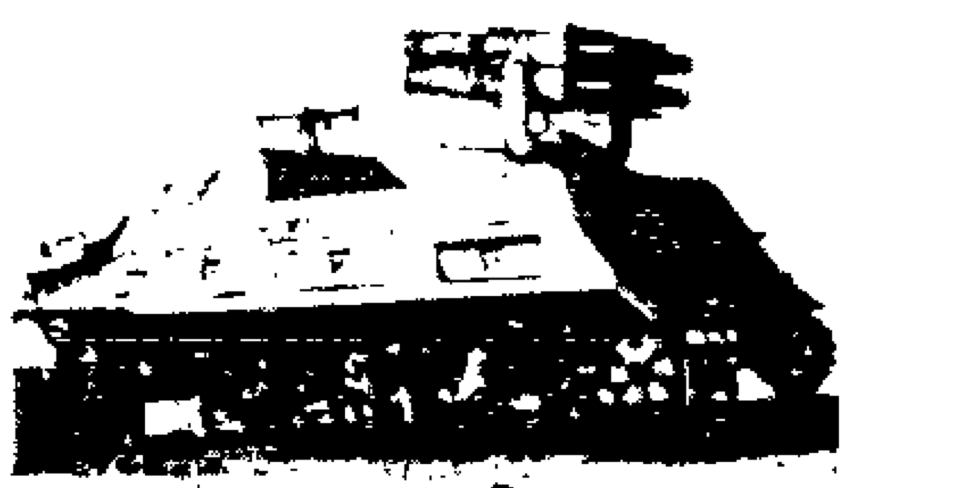
Rocket Launcher (28/32 cm Wurfgerät 41)

Launcher (28/32 cm Nebelwerfer 41)



Launcher (15 cm Nebelwerfer 41)

Launcher (Do-Werfer or Wurfgerät)



Launcher (15 cm Panzerwerfer 42)

k) A four frame launching stand (Wurfgerät) for the 280 mm HE rocket (28 cm Wk Spr) (p 251).

(See also under Weapons).

Rocket Projectile. See Rocket-Assisted Shell.

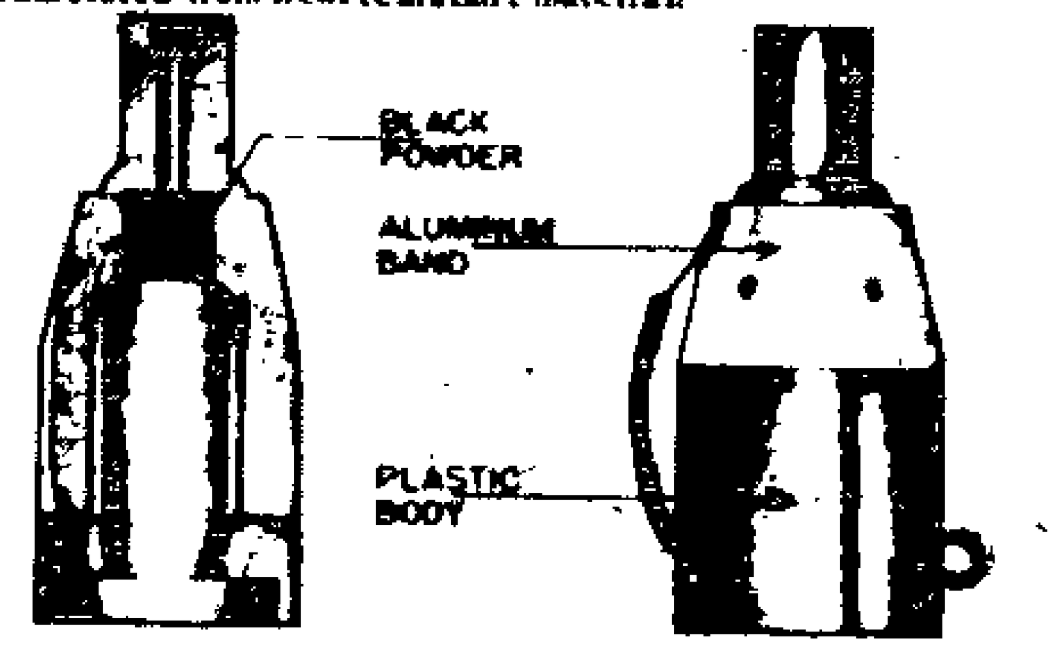
Note: Rocket-assisted projectiles were fired either from howitzers or guns. For instance the 15 cm RGr 19 was fired from the 15 cm sFH 18 (heavy field howitzer 18) and the 28 cm RGr 4331 was fired from the 28 cm K5 (E) (railroad gun 5) [See TM 9-1985-3 (1953), pp 509 & 527]

Rocket Propellant. According to T.Urbański, Przemysl Chemiczny 27 (4), p 487 (1948), (translated by Dr L.Simon), the Germans used solid double-base propellants containing nitrocellulose and nitroglycerin in their smaller rockets. The larger types, such as the V-2, used liquid propellants consisting of a fuel (such as alcohols, hydrazine, fuel oil etc) and an oxygen carrier (such as hydrogen peroxide, nitric acid, tetranitromethane, etc). Mixtures of easily oxidizable organic liquids with hydrogen peroxide of 80-85% concentration were the most widely used. Hydrogen peroxide could also be used as the driving force, without any fuel, because the heat liberated according to the reaction of decomposition:

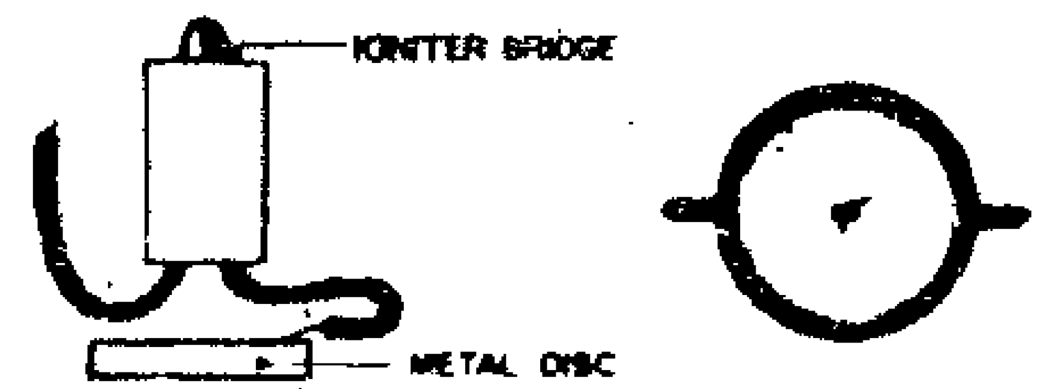
$$H_2O_2 \rightarrow H_2O + \tfrac{1}{2}O_2 + 23150 \text{ kcal}$$

was sufficiently great. Water (vapor) and oxygen served as driving forces.

Rocket Propellant, Igniter ERZ 39, briefly described on p 623 of TM 9-1985-3 (1953), fitted into one of the venturi of the 15 cm and 21 cm rockets. Its body, made of a plastic with an aluminum band around the shoulder, contained an igniter bridge from which ran two wires. One wire was connected to the aluminum band around the shoulder and the other to a metal disk in the base of the fuze. Just above the igniter bridge was located a black powder charge. When an electric current passed through the bridge it ignited the black powder, which in turn ignited the propellant. This modified version of igniter (ERZ 39B) was manufactured from heat resistant material.



ERZ 39



Rocket Propellant Inhibiting Coating. In order to prepare a stick of propellant so that it would burn from an end and not on the sides, the claim was made that it was sufficient to cover the sides of each stick by dipping it twice into a special composition developed at the Düneberg Fabrik of the Dynamit A-G. This composition consisted of: polyvinylacetate 25, lithopone ($ZnS + BaSO_4$) 30, methylacrylate 5 and water 40%.

Reference: A.A.Swanson and D.D.Sager, CIOS Rept 29-24 (1946), p 5 (As reported by Dr H.Leunig).

Rocket Propellants, Liquid. The following liquid rocket propellants were used by the Germans during WW II:

a) Concentrated hydrogen peroxide and C-Stoff was used in the Ba 349B Natter Rocket (surface-to-air)

Note. C-Stoff is a 50/50 mixture of methanol and hydrazine hydrate, $N_2H_4 \cdot H_2O$

b) Concentrated nitric acid and Visol-6 was used in the Enzian E-4 Rocket, Rheintochter R-3 Rocket and Wasserfall Rocket

Note: Visol-6 is vinylethyl ether

c) Concentrated nitric acid and Tonka were used in the Rohrstahl X-4 Rocket

Note: Tonka is a mixture of aniline, monoethylaniline, dimethylaniline, gasoline, naphtha, triethylamine and isohexylamine

d) Concentrated hydrogen peroxide with K permanganate was used in the Hecht Rocket

e) Liquid oxygen, alcohol and water were used in the V-2 Rocket and Feuerlilie-55 Rocket

Note: The noncombustible substance, water, was incorporated in order to keep the flame temperature as low as possible so as to reduce the mechanical strain on the motor without sacrificing too much performance. It was found that the addition of 25% of water to absolute alcohol lowered the chamber temperature 7%, while the exhaust velocity was lowered only 3.5%

f) Concentrated nitric acid, xylidine and triethylamine were used in the Schmetterling Hs117 Rocket

g) Concentrated nitric acid and butyl ether were used in the Taifun Rocket

h) Compressed oxygen and gasoline were used in the V-1 Rocket

Note: In addition to these, the following substances were used in liquid fuels: aniline, ethylideneaniline, ethylidinedianiline, acetaldehyde, naptha, gasoline, dimethylaniline, monomethylaniline, triethylamine, isohexylamine, etc. In some of these liquids, such as aniline, Visol-6 etc pyrocatechol (Brenzkatechin in German) was dissolved.

References:

1) H.Gartmann, Weltraumfahrt 6, 134-9 (1951). Jato and Auxiliary Rocket Propellant Plants

2) K.W.Gatland, Development of the Guided Missile, Philosophical Library, N Y (1952), pp 112-127

3) J.G.Tschinkel, Chem Eng News 32, 2582-87 (1954). Propellants for Rockets and Space Ships.

Rocket Propellants, Solid. All known German propellants of WW II were based on NC and a nitric ester, such as NG, DEGDN, or TEGDN.

Table 53 lists some of the rocket propellants examined at Picatinny Arsenal during WW II

(See next page).

Donin and Donovan (Ref 5) give the burning rates (in inches per second) at various pressures for the solid propellant used in the 210 mm Rocket (See Table 54 on next page). The composition of the propellant is given in Table 53

The same investigators give the rates of burning for the Jet-Assisted-Take-Off-Unit Propellant listed in Table 53

(See Table 55 on next page).

Table 53
Rocket Propellants, Solid

Form	Composition, %								Uses
	NC	%N in NC	NG	DEGDN	Cent	Acar	Graphite	Other Ingredients	
SP	62.5	12.0	33.0	-	-	0.2	0.1 (incor)	EtPhUret 1.5, DPhUret 1.8, Unac 0.9%	150 mm HE Rocket
SP	58.7	12.7	-	35.3	-	0.2	0.3 (incor)	EtPhUret 1.3, DPhUret 2.5%, Unac 1.7%	210 mm Rocket
-	84.1	12.7	12.7	-	0.8	2.4	-	-	210 mm Rocket (Igniter Pad)
-	89.2	12.7	-	5.3	0.9	-	-	DPhA 2.6, Unac 2.0%	210 mm Rocket (Head Igniter Diaphragm)
Cyl	59.6	12.5	-	33.6	-	-	0.2 (incor)	DPhUrea 1.5, DPhUret 3.0, Unac 2.1%	75 mm Leaflet Rocket
-	64.7	12.0	-	29.3	-	0.2	0.1	EtPhUret 3.5, DPhUret 1.3, (TiO_2*$BaSO_4$) 0.9%	Jet Assisted Take Off Unit

Abbreviations: Acar Acardite; Cent Centralite; Cyl Cylinder; DEGDN Diethyleneglycoldinitrate; DPhA Diphenylamine; DPhUrea Diphenylurea; DPhUret Diphenylurethane; EtPhUret Ethylphenylurethane; HE High explosive; incor incorporated; N Nitrogen; NC Nitrocellulose; NG Nitroglycerin; psi pounds per square inch; Unac Unaccounted.

Notes:

a) The composition of the German 150 mm rocket propellant containing NG does not represent anything new except the combination of several stabilizing agents. The same combination was noted in rocket propellants containing DEGDN

b) While the characteristics of the German rocket propellants containing DEGDN are of interest, they show nothing that is new as far as the composition is concerned. The 210 mm rocket propellant was made from NC, with a viscosity of 5.38 poises at 25°, which was plasticized with DEGDN and rolled into a sheet. This in turn was rolled into a "carpet" which was extruded through a hot die to give a single-perforated cylinder. It seems that a small amount of carnauba wax was used as a lubricant to facilitate extrusion

c) Combinations of disubstituted urethanes with either centralite or acardite (asym diphenylurea) were used as stabilizers because it was believed that mixtures are more effective than single stabilizers such as DPhA. To this may be added that, according to M.Tonegutti [S S 32, 302 (1937)], the disubstituted urethanes are very good stabilizers for double-base propellants, especially when used in combination with acardite, while without the latter they are much less effective.

Note: Some rocket propellants and igniters analyzed at Picatinny Arsenal are listed under Propellants (See Tables 43, 44, 45b and 48).

Table 54
Burning Rates of 210 mm Rocket Propellant
(Inches per second)

Temp °C	Pressure in psi				
	300	1500	2500	3500	4500
- 25	-	0.30	0.42	0.55	-
+ 50	0.21	0.43	0.55	0.73	0.93

Table 55
Burning Rates of the Jet-Assisted-Take-Off-Unit Propellant

Temp °C	Pressure in psi					
	800	1000	1500	2000	3000	3500
- 25	0.15	0.18	0.25	0.33	0.45	0.48
+ 50	0.22	0.27	0.39	0.47	0.59	0.66

According to Ref 4, the Reinsdorf Fabrik W A S A -G manufactured during WW II several types of rocket propellants. Their compositions are given in Table 56

Table 56
Rocket Propellants, Solid of W A S A -G

Components and some properties	Designation				
	RGI	R6m	Z135	Z195	Z167
Nitrocellulose (NC)	59.80	57.70	49.10	63.25	54.90
% Nitrogen in NC	12.5	12.5	12.7	12.5	12.5
Diethyleneglycol dinitrate (DEGDN)	35.30	38.00	30.00	-	16.35
Triethyleneglycol dinitrate (TEGDN)	-	-	-	22.00	-
Pentaerythritol tetranitrate (PETN)	-	-	20.00	6.00	6.00
Ethylphenylurethane	1.10		-	-	-
Diphenylurethane	0.90	-	-	-	-
Dibutylphthalate	-	3.00	-	-	-
Acardite), $CO(NH_2)N(C_6H_5)_2$	0.30	0.50	0.75	0.50	0.50
Graphite	-	0.30	0.10	-	-
Magnesium oxide	0.25	0.50	0.05	-	-
IG Farben Wax E	0.35	-	-	-	-
Potassium nitrate	0.60	-	-	-	-
Lignin	-	-	-	-	0.75
Hydrocellulose	1.50	-	-	0.75	
Trinitrotoluene (TNT)	-	-	-	3.00	12.50
Dinitrotoluene (DNT)	-	-	-	4.50	9.00
Moisture (not included in total)	1.00	0.65	1.00	1.00	0.90
Oxygen Balance, %	- 7.11	- 7.93	+ 0.10	- 9.31	-9.92
Calorific Value kcal/kg	905	887	1071	868	826

* Titanium oxide (TiO_2)

References:

1) A.J.Phillips, Pic Arsn Tech Rept 1282 (1943); Ibid 1456 (1949)

2) Collective Data on Foreign Ammunition, PB Rept 11,544 (1945)

3) M.N.Donin & J.J.Donovan, Captured Enemy Propellants, OSRD of NDRC, Div 3, Sect H, Final Rept, Series P, No 10.2 (1945) (Unclassified) (OSRD 5855)

4) F.J.Krieger & M.Plesset, PB Rept 7826 (1945), p 6

5) F.Bellinger, Ind Engrg Chem 38, pp 160-9 (1946)

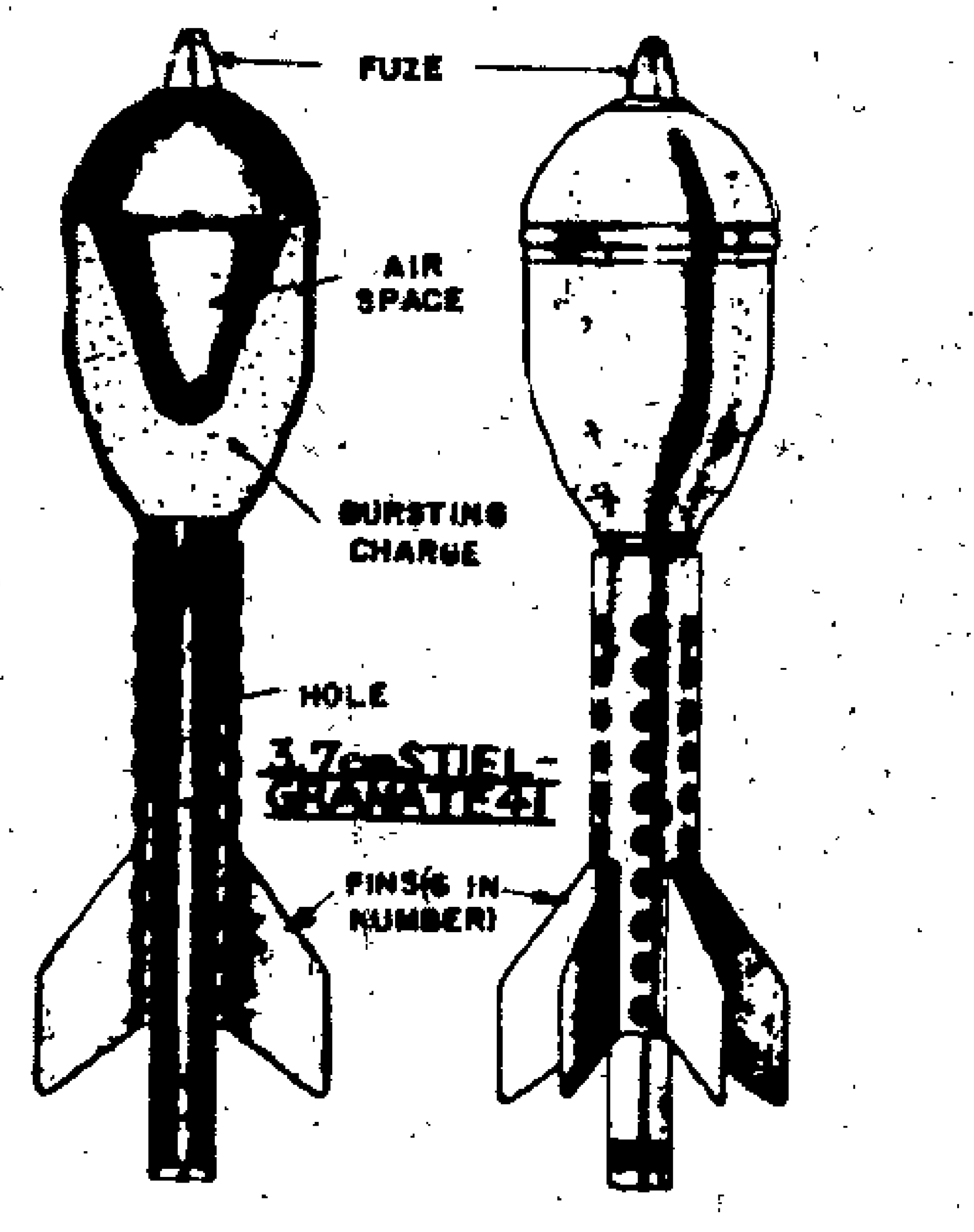
6) R.Levy, Chimie & Industrie, 57, 221 (1947)

7) J.G.Tschinkel, Chem Eng News 32, 2582-87 (1954) "Propellants for Rockets and Space Ships".

Rocket Signal Simulating Device (15 cm Raketen Scheinschuss Gerät, abbreviated as RSSG). See under Pyrotechnic Antipathfinder Devices.

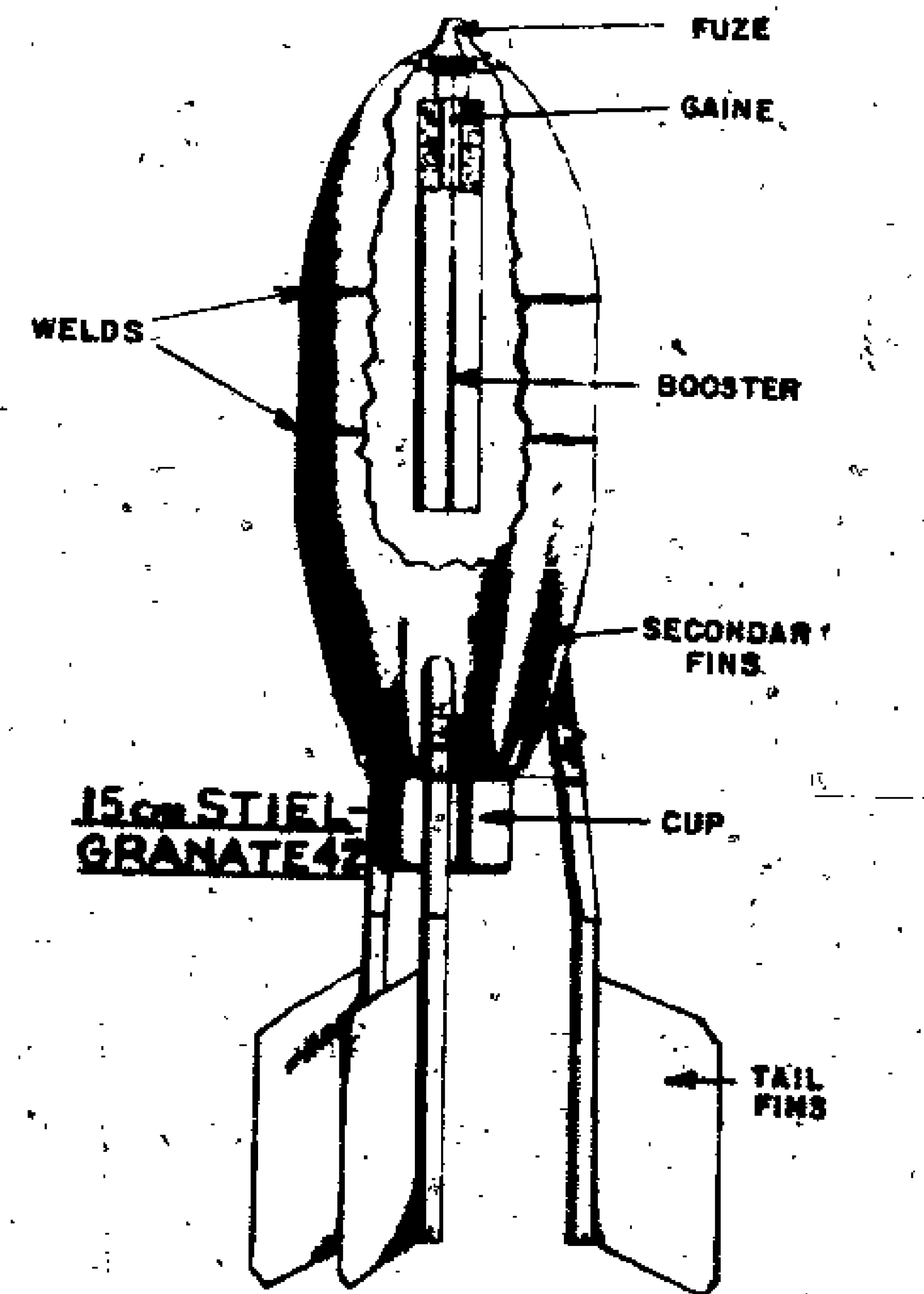
Rodded Bomb or Stick Granade (Stielgranate). The following rodded projectiles are described in TM 9-1985-3 (1953), pp 383-4 & 498-500:

a) 3.7 cm Stielgranate 41 used in the Antitank Gun, 3.7 cm Pak 41 (Panzerabwehrkanone 41) consisted of an egg-shaped head (body) and a cylindrical tail provided with 6 fins. The head contained a shaped bursting charge consisting of 5.28 lb of 60/40-RDX/TNT (2 blocks wrapped in wax paper), two boosters (KzZdlg),



a nose fuze (AZ 5075) and a base fuze (BdZ 5130). The tail portion of the projectile consisted of a rod which fitted into the bore of the gun, and a concentric perforated sleeve which fitted over the barrel of the gun. Tubular double-base NC-NG propellant (NglRP), 6.61 oz, enclosed in a cartridge case, closed by two cork discs, was used as the propellant. Total weight of projectile 18.26 lb and overall length 27.362".

b) 15 cm Stielgranate 42 used in 15 cm sIG 33 (schwerer Infanteriegeschütz 33) (Heavy Infantry Gun) consisted of an elliptical-shaped body, 11.5" max diameter, and a rodded tail section provided with large fins. The body contained 60.0 lb of 60/40-Am nitrate/TNT (bursting charge), a long booster and a nose fuze (WgrZ 36). Small, secondary fins were attached to the rear of the body. A cup with a machined surface was attached at the base. It is presumed that the bomb was provided with a large rod which fitted over the cup and



entered the muzzle of the gun before firing. This rod dropped from the projectile about 150 yd from the muzzle. The bomb was propelled by 12.1 lb of propellant contained in a semi-fixed cartridge case. Total weight of the projectile was 105.0 lb and overall length 50.5". It was used against personnel and to clear minefields and wire obstacles.

c) 37 mm Hollow Charge Stick Rifle Grenade, briefly described under Rifle Grenades, was similar to the 3.7 cm Stielgranate 41

(See also Stick Hand Grenade).

Roheisenzünder Pulver (RZP). Finely pulverized iron prepared by atomizing molten cast iron by a cone of moist air at a pressure of 2 to 3 atm. During this process most of the carbon was oxidized to CO_2 and thus removed. A large part of the iron was also oxidized during atomizing but it was recovered as pure iron on subsequent cooling in water and reduction with hydrogen. This powder was used in the manufacture of sintered iron items many of them of military use.
Reference: CIOS Final Rept 595 (1945), p 52.

Röhrenpulver (RP) (Tubular Propellant). A propellant similar in form to the British Cordite. The compositions of some tubular propellants are given in Refs 1 and 2.

a) NC 64, NG 33 and vaseline 3% (Ref 1)

b) Guncotton (Schiesswolle) 66, TNT 25, DNT 5.5, centralite 0.5, K bitartrate 2.0 and moisture 1.0% (Ref 2, p 134)

c) Collodion cotton 32-34, guncotton 32-34, NG 25-29, centralite or urethane 4 to 7, Am oxalate 0.5, Na bicarbonate 0.5, graphite 0.1 and moisture 0.9% (Ref 2, p 136)

References:

1) E. de B.Barnett, Explosives, Van Nostrand, N Y (1919), p 78
2) H.Brunswig, Das rauchlose Pulver, W. de Gruyter, Berlin (1926), pp 134 & 136.

Röhrenpulver C/32 (RPC/32). (Tubular propellant, pattern 1932). It contained: NC 64.76, NG 26.87, Et centralite 5.71, Na nitrate 0.36, graphite 0.20 and volatile matter 0.56%. Was used in fixed artillery ammunition, calibers 150 mm, 170 mm, 203 mm and 240 mm.
Reference: TM 9-1985-3 (1953), p 504.

Röhrenpulver C/38 (RPC/38). (Tubular propellant pattern 1938). According to the Manual entitled: German Artillery Projectile and Fuzes, published during WW II at the Aberdeen Proving Ground, Md, p 183, the RPC/38 propellant was used in 150 mm HE Projectile, 4.5 calibers long, with point detonating fuze under ballistic cap. Although the composition is not given in the above manual, it is safe to assume that the RPC/38 was one of the diethyleneglycol-dinitrate propellants developed at that time by Gallwitz (See "G" Pulver).

Rohpulvermasse (Raw Propellant Mass, called also Raw Paste). This was a mixture of water-wet nitrocellulose with an explosive oil which consisted of one or several organic nitric acid esters, such as NG, DEGDN or TEGDN. Such mixtures could be safely transported when the smokeless propellant plant was not located adjacent to the plants manufacturing NC and nitric esters. For instance, the Krümmel Fabrik of D A -G manufactured NC and organic acid esters, while the Düneberg Fabrik, situated about 4 miles away, made the solventless propellants. As it was not safe or convenient to ship liquid explosives, the Krümmel plant mixed them with water-wet nitrocelluloses prepd by blending guncotton (Schiesswolle) (N=13.15% to 13.2%) and collodion cotton (PE-Wolle)(N=11.30 to 11.45%), packed the mixture in rubber-lined linen bags and shipped them to the Düneberg plant to be used for the preparation of solventless propellants.

For the prepn of Rohpulvermasse about 280 kg of NC (calculated on the dry weight) was stirred for about 10 minutes with water. About 120 kg of a nitric ester was added to the mixture and stirring was continued for 10 minutes. The slurry was then transferred to a centrifuge where the water content of the mass was reduced to 30-35%. The resulting Rohpulvermasse was packed in rubber-lined linen bags and transported to the Düneberg plant.

When received at the plant, the required number of bags were emptied into large drums. After the contents of the bags were blended, the mixture was transferred to the preheated Werner-Pfleiderer kneaders. The other ingredients of propellants such as stabilizers, graphite, Mg oxide, etc were added in the kneader and, after allowing the blend to mature for about one week (two weeks for NGu propellants), it was passed through a hellical screw press in order to reduce the moisture content from 30-35% to about 8%. The partially dehydrated product was fed to horizontal rolls, diameter 0.4 m length 1.0 to 2.0 m and rotating at 11 rpm. A temp of 70-80° was used for DEGDN powders. The time of processing was 18 to 30 minutes for a 15 kg sheet. Between 3 and 5% of moisture was allowed to remain in cannon propellants. The resulting sheet was trimmed to size and wound on a brass mandrel about 1 3/4" diam. The sheet could also be used for the preparation of extruded propellants. The extrusion should immediately follow the rolling while the sheet is still hot. It was claimed that the inclusion of 0.25% MgO facilitated the extrusion. It does not seem that any wax was used for lubrication. The resulting extruded propellant contained 3 to 5% moisture and had to be dried in stoves to reduce the moisture to 1.0-1.2%.

Reference:
O.W.Stickland et al, General Summary of Explosive Plants, PB Rept 925 (1944), pp 6, 10 and 65.

Rohtri. German designation for Crude Trinitrotoluene.

Romperit I (Romperite I). A mining explosive contg approximately: Am nitrate 86, NG with nitroglycol 8 to 10%, the rest being TNT, aluminum and other ingredients.
Reference:
F.Weichelt, Handbuch der gewerblichen Sprengtechnik, C.Marhold, Halle/Saale, (1953), p 37.
(See also Donarit and Gelatine-Romperit).

Rotierende Trommel (Rotating Drum). An apparatus for determining the velocity of detonation and for other purposes. See general section and also A.Stettbacher, Spreng- and Schiesstoffe (1948), pp 11-12.

"Rotram" Separator. This apparatus, installed at the Krümmel Fabrik A -G in conjunction with the Holländer beater, was used to remove the fines of NC from the slurry as fast as they were produced on beating. A considerable saving in power and in time was claimed for the Rotram.
Reference: A.A.Swanson & D.D.Sager, CIOS Rept 29-24 (1946), p 7.

Royal Tiger (Königstiger). See under Panzer.

RPC/12. One of the earliest solventless propellants. It was prepd about 1909 by Thieme and collaborators at the Zentralstelle für Wissenschaftlich-technische Untersuchungen in Neubabelsberg by incorporating 70 parts of NC (N=11.7%) with 25 p of NG and 5 p of centralite. It was suitable for use in large caliber guns [P.Tavernier, Mém poud 32, 253 (1950)].
(See also under Propellants, Artillery).

RPC/32 (Röhrenpulver Construktion 32). A tubular propellant introduced in 1932 for use in the 150 mm Naval Gun (15 cm SK), 150 mm Gun in Mortar Mount (15 cm K ins MrsLaf), 170 mm Railroad Gun (15 cm K(E)]and in some other guns. Its approximate composition was: NC 64.7, NG 26.9, ethyl centralite 5.7, Na nitrate 0.6, graphite 0.2 and volatile matter 1.9%.
Reference: TM 9-1985-3 (1953), pp 504-516.

RRP (Rauchloses Rottweiler Pulver). Smokeless propellant manufactured at the beginning of the present century by Vereinigte Köln-Rottweiler Pulverfabriken in Württemberg. This propellant was exported to Belgium and other countries.
Reference: J.Daniel, Dictionnaire des Matières Explosives, Dunod, Paris (1902), p 696.

R-Salz (R-Salt) described in the general section as Cyclotrimethylenetrinitrosamine, was prepd in Germany by Röger et al by treating hexamethylenetetramine (hexamine) with sodium nitrite in acid solution.

R-Salz was proposed as an ingredient of explosive mixtures.

Table 57 lists these explosives

Table 57
R-Salt Explosives

Ingredients and Some Properties	Composition (%) of Mixtures: 1	2	3	4	5	6	7	8
R - Salz	96.5	46.5	36.5	46.5	36.5	96.5	36.0	40.0
Phenanthrene	2.5	2.5	2.5	2.5	2.5	-	-	-
Diphenylamine	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-
RDX (Hexogen)	-	50.0	50.0	-	40.0	-	50.0	40.0 (H_s)
Aluminum powder	-	-	10.0	-	20.0	-	-	20.0
K nitrate	-	-	-	50.0	-	-	-	-
Dimethylethylenedinitramine	-	-	-	-	-	2.5	12.0	-
Unaccounted	-	-	-	-	-	-	1.0	-
Casting Temp °C	92	92	95	94	95	92	84	-
Density (cast)	1.55	1.65	1.64	1.77	1.74	1.55	-	-
Veloc of Deton, m/sec	7600	-	-	6100	7750	7850		-
Pb Plate Test. The mixture is more effective than	TNT	Cyclotol	40/60 Amatol	40/60 Amatol	40/60 Amatol	-	-	-
Fragment Density Test (TNT = 40 m)	44 m	47 m	47 m	47 m	-	-	-	-
Stability at 100°	Satisfactory stability for all explosives							
Exudation at 70°	No exudation for any of the explosives							

Notes:

a) H_s is Hexogen (RDX) phlegmatized with 5% Montan wax

b) Mixture (8) was claimed to be very powerful

c) R - Salt forms with 20% dimethylethylenedinitramine (DMEDNA) a eutectic mixture, freezing point (fr p) 74°. Fr p of R - Salt with 10% DEMEDNA is 89° and with 5% DMEDNA 93°. Fr p of R-Salt alone 104-106° and of DMEDNA 137°.

Reference: G.Römer, Report on Explosives, PBL Rept 85,160 (1946), pp 3-15.

RSSG (Raketen Scheinschussgerät). Rocket Signal Simulating Device. See under Pyrotechnic Antipathfinder Devices and also in CIOS Rept 32-56 (1945), p 3.

RZ 73 "Flight". A 73 mm air-to-air missile developed in 1941 by converting an Army rocket. It used a solid propellant and could be considered as the predecessor of R4M (q v).
Reference: K.W.Gatland, Development of the Guided Missile, "Flight" Publication, London (1952), pp 122-3.

"RZ" Smoke Cartridges. See under Smoke Composition and Devices.

S-1 to S-18 Explosives. See under Unterwassersprengstoffe.

S-6 and S-6 Mod Explosives. See under Ersatzsprengstoffe.

S-16 and S-19 Explosives. See under Ersatzsprengstoffe.

S-19 and S-22 Mod Explosives. See under Ersatzsprengstoffe.

S-22 and S-26 Mod Explosives. See under Ersatzsprengstoffe.

Sabot Projectile (Treibspiegelgeschoss) consisted of a relatively small subcaliber projectile carried in a relatively large casing (sabot) of softer material. The latter was discarded as the projectile left the bore of the gun. The principle of this projectile was to have a large surface exposed to the pressure of propelling gases and then to have the surface reduced so that the air resistance became small. These projectiles were never very accurate.

One type of German sabot projectile was armor-piercing and consisted of a sintered tungsten carbide core and the softer sabot which was not discarded until the core began to penetrate the target (such as the armor of a tank). After this the core disintegrated, which caused a deadly spray of fine fragments inside the target (such as a tank).

Some of the sabot projectiles, described in Ref 2, were provided with one or two discarding bands, each in one piece. They were fired from normal rifled guns. Some of these projectiles were called Disintegrating Rotating Bands Projectiles (q v).

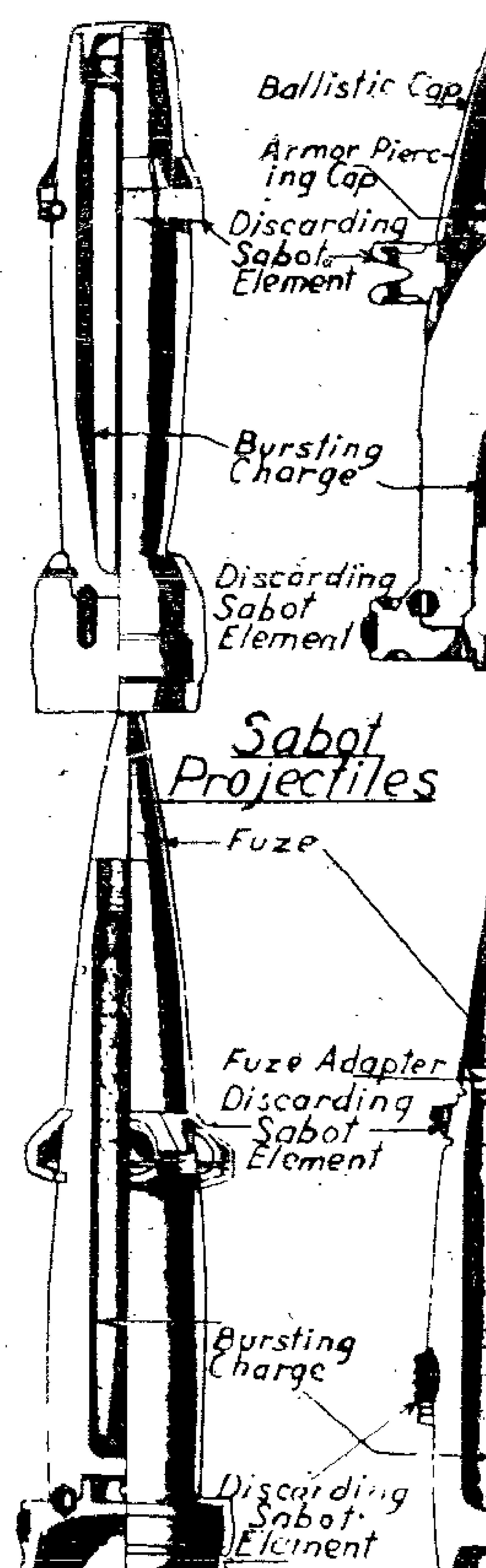
References:

1) L.E.Simon, German Research in WW II, Wiley, N Y (1947), p 189
2) Dept of the Army Tech Manual TM 9-1985-3 (1953), pp 363-70 (See drawing on next page).

Safety Jelly Dynamite. One of the older permissible explosives: NG 32.25, collod cotton 1.25, glue-glycerin-dextrin jelly 9.60, rye flour 18.00, Am nitrate 22.60, Na nitrate 10.80 and K chloride 5.50%.
Reference: P.Naoúm, Nitroglycerin, Baltimore (1928), p 407.

"Salbei" Code name for either 99.5% HNO_3 nitric acid or its mixture with 5 to 10% sulfuric acid when used as an oxygen carrier in liquid rocket propellants. One of the liquid fuels used in conjunction with Salbei was Tonka (q v). H_2SO_4 was added to suppress corrosion.
References:

1) CIOS Rept 28-56 (1945), p 26
2) TM 9-1985-2 (1953), pp 216 & 231.



Salit (Salite) One of the older permissible explosives: NG 11.8, collodion cotton 0.5, Am nitrate 53.6, DNT 8.5, Na chloride 23.1 and carbohydrates 2.5%; Trauzl test value 287 cc and "charge limit" 660 g.
Reference: A. Marshall, Explosives, London v 1 (1917), p 397.

Salpetersäure. See Nitric Acid.

Sänger-Bredt Missile, called **Antipodal Bomber,** was a supersonic rocket designed by Dr. E. Sänger before 1942, but the project work was abandoned without any practical development. This design embodied many unique features, which are briefly described by Gatland on pp 57-8. It was planned to use the rocket in regions above a dense atmosphere. Each time it dived and hit a denser layer of air, the missile was supposed to bounce upwards. These movements would produce a kind of wave-shaped trajectory, similar to that obtained when a flat stone is ricocheted across water, but much less pronounced. As each plunge into a denser air would result in a partial loss of kinetic energy of the missile, the initially long jumps would gradually become shorter, finally to be transformed into an even gliding flight. It was presumed that this method would achieve a stable flight and a more accurate trajectory in a region above dense air, where conventional missiles usually behave rather erratically. The rocket was designed to be catapult launched and to be propelled by an oil/liquid oxygen mixture. Its calculated characteristics were: launching weight 220,500 lb, overall length (less booster) 91.8 ft, width of rectangular section 5.9 ft x 11.8 ft, maximum range 14,600 miles and maximum altitude 93 miles.
Reference: K.W.Gatland, Development of the Guided Missile, "Flight" Publication, London, (1952) pp, 57-8 & 124-5.

Sarin. See under Trilone.

Satzröhrchen. An igniter contg a compressed mixture of meal powder (Mehlpulver) with a slow-burning substance such as a mixture of sulfur and K nitrate.
Reference: Kast-Metz, Chemische Untersuchung, (1944), p 535.

Sauerstoffbilanz oder Sauerstoffwert (Oxygen Balance or Oxygen Value), abbreviated to O B. It may be determined in the manner described in the general section or by the method given in A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 16-18.

Säulenknetmaschine. See under Knetmaschine.

Saxonia Pulver. One of the pre-WW II sporting smokeless propellants: guncotton 95.0, TNT 4.0 and gelatinizer with some moisture 1.0%.
Reference: H.Brunswig, Das rauchlose Pulver (1926), p 134.

Scheffler - Glöckl Fusehead Comb, invented before WW II in Austria, was later improved and used at the Troisdorf Fabrik, DAG. It is briefly described in BIOS Final Rept 644 (1945), pp 9-11. In Germany, this comb replaced the previously used Kronnichfeldt pressboard galvano-type comb.

Scheidemehl (Dust of Picked Ore). A mixture consisting chiefly of Ca and Mg silicates was used during WW II in some substitute explosives (Ersatzsprengstoffe) as an extender of nitrocompounds which were not available during the war in sufficient quantity.
Reference: PB Rept 1570 (1945), p 11.

Schiessbaumwolle. See Schiesswolle.

Schiessbecher. A rifled, caliber 30 mm, discharger cup which could be fitted to most types of German rifles. Was used for launching some antitank rifle grenades. A photo of the Schiessbecher but no description is given in the Ordnance Sergeant, October 1945, p 9.

This photo is by courtesy of Aberdeen Proving Ground, Maryland.

Schiessmörser (Shooting Mortar). A device used for testing mining explosives in galleries filled with firedamp and/or coal dust.
Reference: M.Lupus, S S 20, 190 (1925).

Schiesswolle (Guncotton). Nitrocellulose of 13.2-13.3% nitrogen content, corresponding approximately to the Amer Guncotton. It was used in the manufacture of some smokeless propellants (See also Nitrocellulose and under Propellants).

Schiesswolle (Schw) Explosiven. See under Unterwassersprengstoffe.

Schiesswolle 18 oder TSMV1-101. An explosive described as **Hexamite** (Hexanite) in the general section. It consisted of TNT 60, hexanitrodiphenylamine 24 and Al powder 16% and was used in sea mines, torpedoes, depth bombs and underwater demolition charges.
References:
1) A.Stettbacher, Protar 9, 33-43 (1943)
2) H.Muraour, Protar 9, 62-63 (1943)
3) Allied and Enemy Explosives, Aberdeen Proving Ground, Md. (1946)
4) A.Stettbacher. Spreng- und Schiesstoffe, Rascher, Zürich (1948), p 78.

Schlagweite. (Striking Distance). Same as Detonationsübertragung.

Schlagwettersichere Sprengstoffe, oder Wettersprengstoffe. Explosives safe for use in coal mines with fire damp. **(See Wettersprengstoffe, p 226 and also Sicherheitssprengstoffe)**
References:
1) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 246
2) C.Beyling, K.Drekopf, Sprengstoffe und Zündmittel, Berlin (1936), p 105
3) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 91.

Schlagwetterversuchstrecke, oder Versuchstrecke (Firedamp Testing Gallery). Description of galleries for testing explosives in regard to their suitability for use in gaseous coal mines is given in the general section. The first German gallery was constructed in 1885 by Lohmann in Neunkirchen (Westfalen). Other German galleries were: Derne, near Dortmund, Gelsenkirchen-Schalke, Grube-Maria and several galleries belonging to the plants manufacturing mining explosives, such as Schlebusch, Haltern, Castrop etc. One of the newest galleries was in the Sächsichen Braunkohlenrevier zu Freiberg (Sachsen).
References:
1) A.Marshall, Explosives, London, v 2 (1917), p 584
2) A.Schrimpf, S S 24, 288 (1929)
3) A.Stettbacher, Schiess und Sprengstoffe, Leipzig (1933), pp 248-250.

Schmidding-Gerät 33 (SG 33). A rocket booster unit invented by Schmidding to increase the thrust of Hs 117 missile, thus assisting its take-off [TM 9-1985-2(1953), p 201].

Schnecken Presse (Worm Press). In order to reduce the time of the rolling operation and to reduce the power consumption in the manufacture of solventless propellants, the Düneberg Fabrik of Dynamit A-G rolled the NC-NG (or NC-DEGDN) paste (Rohpulvermasse). The water content of this paste had previously been reduced to 8%, instead of 25-30% as was used in the other propellent plants. In order to achieve such good dewatering the usual centrifuging of the paste was followed by passing it through the Schnecken press. The press consisted of a slotted barrel and an endless screw. When the paste was pressed some water escaped through the slots while the partially dehydrated paste was squeezed out ready for rolling into sheets (carpets).
Reference: A.A.Swanson & D.D.Sager, CIOS Rept 29-24 (1946), p 7.

Schnellmine. See Panzerschnellmine under Landminen.

Schnellzeitzünder (Quick Time Igniter), called also Instantaneous Fuse and Quickmatch. Some German igniters, such as **Donnerzünder** and **Eschbachzünder** are described in Beyling-Drekopf, Sprengstoffe und Zündmittel, Berlin (1936), p 229.

Schnorkel oder Schnörkel (Misspelled North-German word **Snorkel** oder **Snort**, meaning Nose). The Dutch had fitted their submarines with an air intake back in 1940, and the Germans modified the device and called it Schnörkel. It consisted of a tube (about a dozen meters long), one end of which was connected to submarine Diesels, while the other end protruded above the surface of the water. The tube was divided lengthwise into two compartments - one for suction of air from the outside and the other for removing the gases of combustion of the Diesels. This device permitted the submarine to operate its Diesels while remaining in the submerged condition. In case of danger, the Schnörkel folded horizontally and the submarine submerged to a depth of as much as 200 m (or even 400 m as was reported for the Submarine 21). As the material of the Schnörkel was usually non-metallic, it could not be detected by radar.

Due to the fact that the Schnorkel used during WW II did not supply an amount of air sufficient to replace all the foul air in submarine, it was necessary to resurface the submarine after several hundred kilometers of underwater travel or equivalent duration. The maximum achieved in an uninterrupted submerged condition was 500 km.

References:
1) A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 20-24
2) H.Schaeffer, U-Boat 997, Norton, N.Y. (1950), pp 182-3.

Schopper-Riegler Test. According to Sheldon (Ref 1) this test was used in Germany to determine the suitability of crepe paper intended for the manufacture of nitrocellulose. The Schopper-Riegler Tester was originally introduced into the paper industry to determine the freeness (slowness) of the wood pulp. The tester operates on the same principles as the Canadian Standard Freeness Tester (Ref 2).
References:
1) L.Sheldon, PB Rept 12,662 (1945)
2) J.N Stephenson, Edit, Preparation and Treatment of Wood Pulp, McGraw-Hill, N Y vol 1 (1950), pp 943, 951 & 955
(See also Freeness and Its Testing, in the general section).

Schrapnellgranate. See Shrapnel Shell.

Schrapnellmine (S-Mine). See under Landminen.

Schuss Zünder (Pressure Type Igniter), also called **Hebelzünder** (Lever Type Igniter) is briefly described under Igniters and in TM 9-1985-2 (1953), p 296. It was used in the Glasmine 43 as an alternative to the Buck igniter.

Schuler Pulver (Schuler Powder). An explosive patented in 1893: K chlorate 60, pulverized anthracite 25 and sugar 15%. A similar explosive was used by the British under the name Schindler Powder.
Reference: Daniel, Dictionnaire, Paris (1902), p 705.

Schultze Pulver (Schultze Propellant). A smokeless propellant prepd, about 1865 by Major Schultze of the Prussian Artillery, by nitrating purified (de-resinated) wood (in the form of small square-cut pieces), followed by washing and boiling the resulting Nitroliginose with water and then drying. After this the grains were impregnated with a a concentrated solution of saltpeter, with or without Ba nitrate, and dried again.

Although this propellant was appreciably slower burning than earlier smokeless propellants consisting of straight compressed nitrocotton (such as Von Lenck Propellant), it was still too quick for use in rifles, although quite suitable for shotguns.

Schultze propellant was manufactured not only in Germany but also in England (1868) and Austria (1870), but it did not achieve any success until it was modified in England by Griffiths and in Austria by Volkmann. The Austrian propellant was made by partly gelatinizing the Schultze propellant with a mixture of ether-alcohol and it became known as Collodin. The British modifications beginning in 1883 contained nitrated wood pulp instead of previously used nitrated wood. The composition of the British sporting Schultze propellant is given in Marshall (Ref 1, p 327).

The composition of German Schultze propellant given by Brunswig (Ref 2) was as follows: collodion cotton 40, guncotton 40, Ba nitrate 10, vaseline 8, moisture 1.5 and gelatinizer 0.5%.
References:
1) A.Marshall, Explosives, London v.1 (1917), pp 47 & 327
2) H.Brunswig, Das rauchlose Pulver, Berlin (1926), p 134.

Schümine One of the Land Mines. See under Landminen.
Reference: TM 9-1985-2 (1953), p 278.

Schuss Gg P-40. Hollow charge rifle grenade described in TM 9-1985-2 (1953) pp 337-8. (See also under Rifle Grenades).

Schützenmine. Same as Schümine.

Schwarzpulver (Black Powder). Composition, preparation and properties of black powders are given in the general section.

Table 58 lists some German military and commercial black powders

Table 58
Black Powder

Designation	Composition, %		
	K nitrate	Charcoal	Sulfur
Geschützpulver, PPC/75 (Cannon propellant 1875)	74.0	16.0	10.0
Militär-Gewehrpulver 71 (Military rifle propellant 1871)	76.0	15.0	9.0
Militärpulver (current)	75.0	15.0	10.0
Marine Geschütz Pulver (Navy Gunpowder)	75.0	16.0*	9.0
Jagdpulver (Hunting or sporting powder)	78.5	11.5	10.0
Sprengpulver (Blasting powder) manufd by the Pulverfabrik Spandau	65.0	20.0	15.0
	70.0	16.0	14.0
	74.0	16.0	10.0
	66.0	21.5	12.5
Blasting powder	65.0 (Na nitrate)	18.0	17.0
Blasting powder B	76.0	14.0	10.0

*Beech charcoal

References:
1) Gody, Traité des Matières Explosives, Namur (1907), p 71
2) R.Escales, Schwarzpulver, Leipzig (1914), pp 160, 169 & 353
3) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), pp 97-112
4) E.Sancho, Química de los Explosivos, Madrid (1942), pp 277-9
5) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 58-9.

Schwefelsäure. See Sulfuric Acid.

Schwergefrierbare Dynamite (Difficultly Freezing Dynamites), called also **Ungefrierbare Dynamite** (Non-Freezing Dynamites). See Low-Freezing Dynamites in the general section.

Screaming Mimi or Screaming Meemie. According to H.H. Bullock of Picatinny Arsenal, Screaming Mimi was the nickname for any ammunition giving off a loud shrill sound in flight. One such item was the WW I 75 mm shell fired from the light, muzzle-loaded rifled mortar, called Minenwerfer. The shell had in the rear several vented holes that allowed air to pass through thus giving a shrill noise. Another item nicknamed Screaming Mimi was the 150 mm Smoke Rocket Projector, 15 cm Nebelwerfer 41, or its ammunition, used successfully during WW II. The weapon, also nicknamed **Woof-Woof**, is briefly described in this section under Rocket Launcher.
(See also the general section).
References:
1) W.B.Larson, Infantry Journal, September 1944, p 23
2) Anon, Intelligence Bulletin, March 1945, pp 2-4.

Sea Dog. See Seehund.

Sea Marker Bomb. See under Marker.

Securite. See Sekurit.

Securophore. See Sekurophor.

Seehund (Sea Dog) (Chien de mer, in French). The "pocket" submarine (16 tons) with a radius of action of 500 km invented near the end of WW II. Its crew consisted of 1 or 2 men and it carried 2 torpedoes. It was provided with a small Diesel, generator, storage batteries, electric motor, oxygen tanks, and an arrangement which allowed it to submerge to as much as 50 or 60 m. This was an effective weapon which could do considerable damage if used in large numbers.

In addition to the Seehund there were two other models of pocket submarines both propelled by electricity. The one, slightly larger than the Seehund, was called **Molch** (salamander), while the other, considerably smaller, was called **Biber** (beaver).
(See also U-Boat, One-Man).
Reference:
A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 31-33.

Seidler Sprengstoff. A permissible explosive patented in 1892 by Seidler of Berlin. It was prepd by blending 77 parts of K nitrate with 23 p of the Na salt of napthalene-beta-monosulfonate, $C_{10}H_7SO_2ONa$ [Daniel, Dictionnaire (1902), p 712].

Sekundärladung (Secondary Charge), called also in English Base Charge, Main Charge, or Lower Charge. A charge in detonators or blasting caps which is placed underneath a primary or an intermediate charge. A secondary charge usually consists of a high explosive more sensitive to initiation than cast P A or TNT. The usual base charges were: compressed tetryl, PETN, or RDX, while charges occasionally used included compressed P A and hexanitromannitol.

Sekurit (Securite). A type of mining explosive based on mono or dinitrobenzenes mixed with an oxidizer such as Am or K nitrate, patented about 1886 by F.Schöneweg.

Table 59 lists some securites

Table 59

Components	Securites				
	1	2	3	4	5
Am nitrate	-	-	37.0	-	-
K nitrate	74.5	77.7	34.0	81.8	18.9
MNB with m-DNB	-	-	29.0	-	70.5
m-DNB	25.5	19.4	-	15.2	-
Am oxalate	-	2.9	-	3.0	-
Nitrocellulose	-	-	-	-	10.6

References:
1) J.Daniel, Dictionnaire des Matières Explosives, Paris (1902), pp 710-12
2) L.Gody, Traité des Matières Explosives, Namur (1902), pp 597 & 708
3) E.Colver, High Explosives, London (1918), p 141
4) F.M.Turner, Edit, Condensed Chemical Dictionary, Reinhold, N Y (1942), p 291.

Sekurophor (Securophore). A type of mining explosive manufd in Germany prior to WW I.

Table 60 gives some examples.

Table 60

Components	Securophores		
	1	2	3
Am nitrate	27.0	24.6	-
Ba nitrate	-	-	1.0
K nitrate	4.0	3.6	34.0
NG	40.0	36.4	25.0
Collod cotton	1.0	0.9	-
Sebacic acid or its salts	12.5	11.4	-
Na chloride	-	9.0	-
Rye flour	10.0	9.1	38.5
Wood meal	2.0	1.8	1.0
Liquid hydrocarbon	3.5	3.2	
Na carbonate or bicarbonate	-	-	0.5

References:
1) L.Gody, Traité des Matières Explosives, Namur (1902), pp 713-714
2) A.Marshall, Explosives, London, v 1 (1917), p 376.

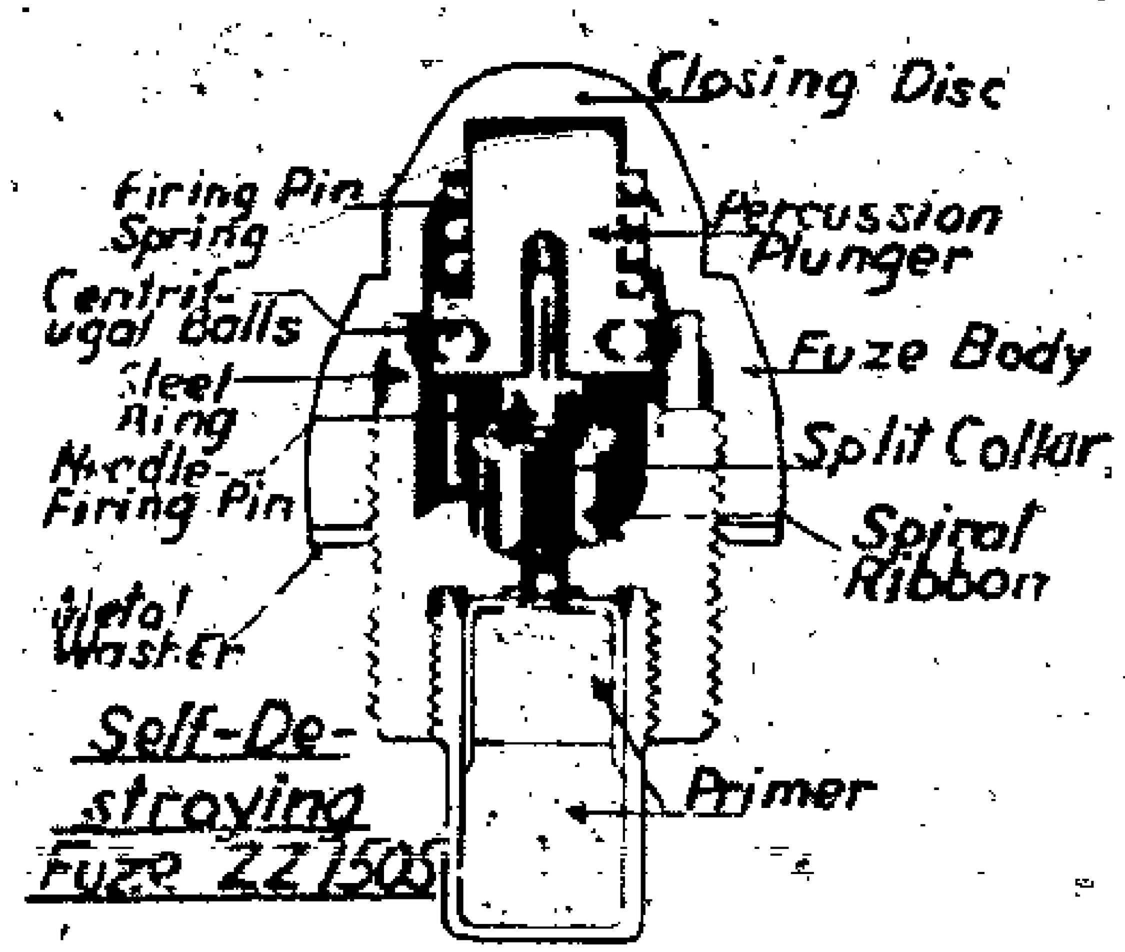
Selbstentzündung Probe (Spontaneous Ignition Test) for pyrotechnic compositions and their ingredients is described in Kast-Metz, Chemische Untersuchung (1944), p 535.

Self Carrying Demolition Charge is described under Krümmel Factory, Dynamit A-G.

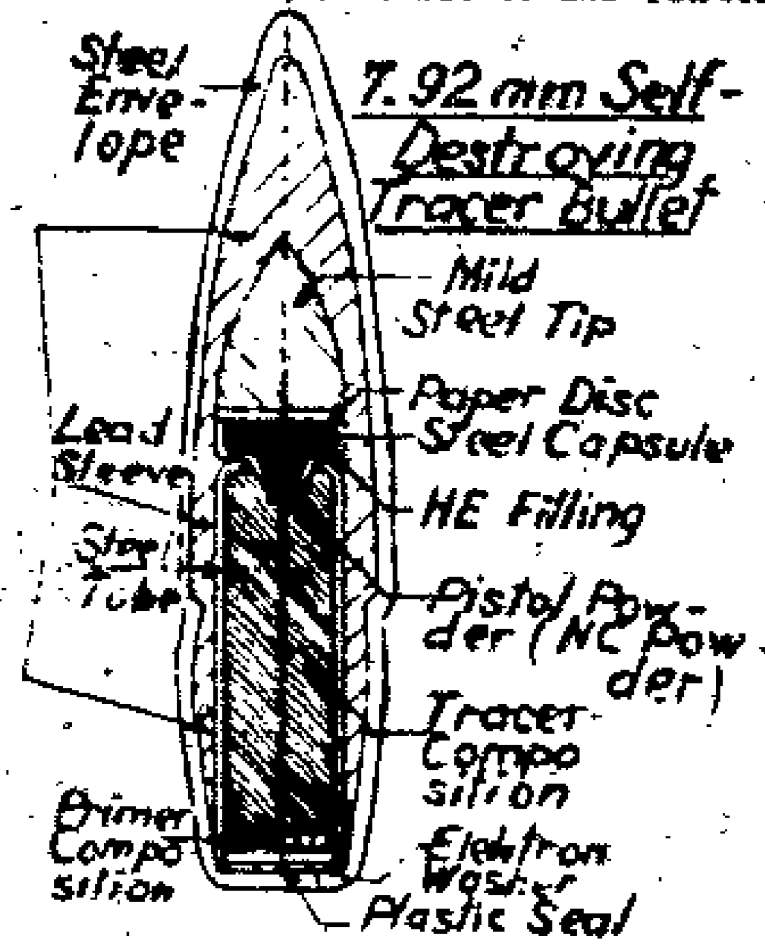
Self-Destroying Bullet. See Self-Destroying Tracer Bullet.

Self-Destroying Fuze, ZZ 1505, developed by the Deutsche Waffen- und Munitionsfabriken A-G, Lübeck, was used in the 20 mm Mauser ammunition in air to ground firing. Like fuze AZ 1502 it was of the sensitive type required to function on a 2 mm paper screen at 100 meters. When the projectile was fired, the centrifugal force caused the steel balls (8) to fly out into the enlarged portion of the retainer ring thus locking the percussion plunger and its compressed spring in place. The same force caused the brass spiral ribbon to unwind and increase in diameter until the shoulder on the striker could pass through its center. By this time the projectile was a few meters away from the muzzle of the gun and the projectile was armed. On hitting the target the steel balls went back into their housings and the firing pin, activated by the compressed spring, pierced the primer cap.

If no impact took place within a range of about 2000 meters, the speed of rotation dropped to such an extent that the thrust of the balls against the angle surface was insufficient to support the firing pin spring. The primer was then fired and the projectile destroyed in the air.
References:
1) H.Peploe, CIOS Rept 33-20 (1945), pp 69-70
2) Anon, TM 9-1985-3 (1953), pp 548-9.



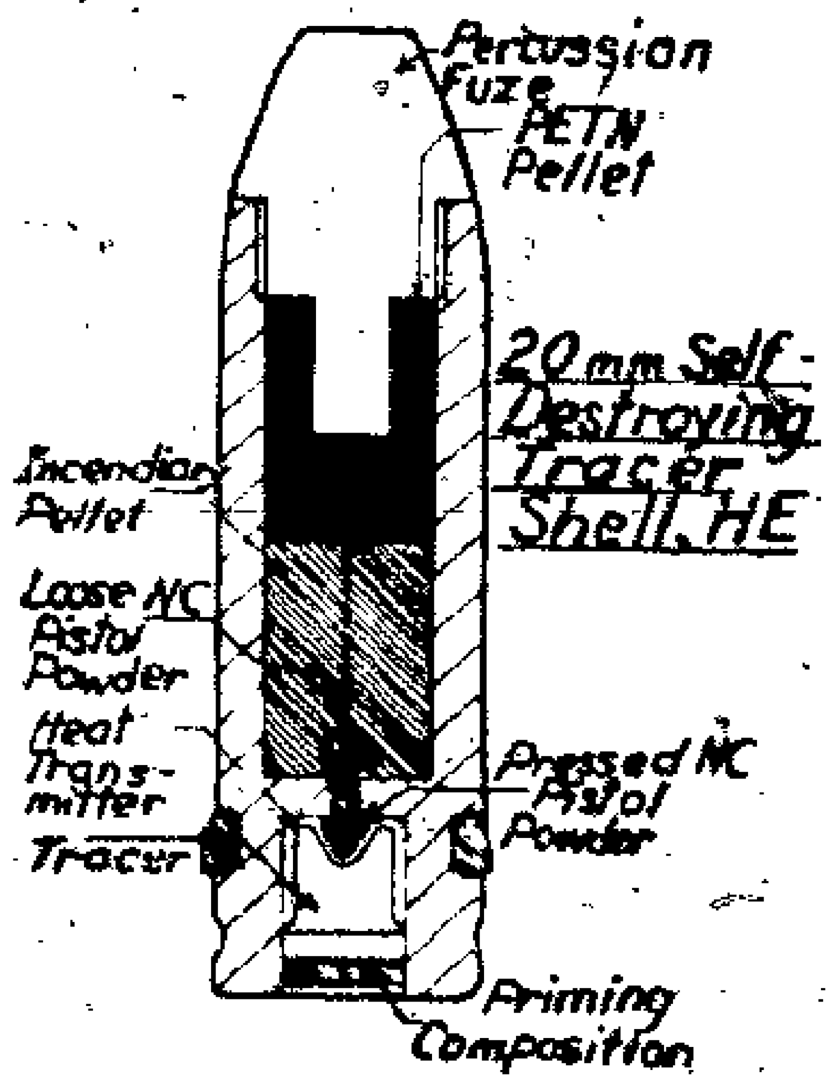
Self-Destroying Tracer Bullet (Spitzgeschoss mit Stahlkern, Leuchtspur mit Zerlegung) caliber 7.92 mm, developed during WW II by the Deutsche Waffen- und Munitionsfabriken A-G, at Lübeck, was intended to be used for air to air practice firing. It consisted of a steel casing containing a lead sleeve which enclosed a mild steel tip, a steel capsule with HE explosive filling and pistol powder, and a steel tube with tracer and primer compositions. The HE filling consisted of PETN 40, Pb azide 45 and Tetracene



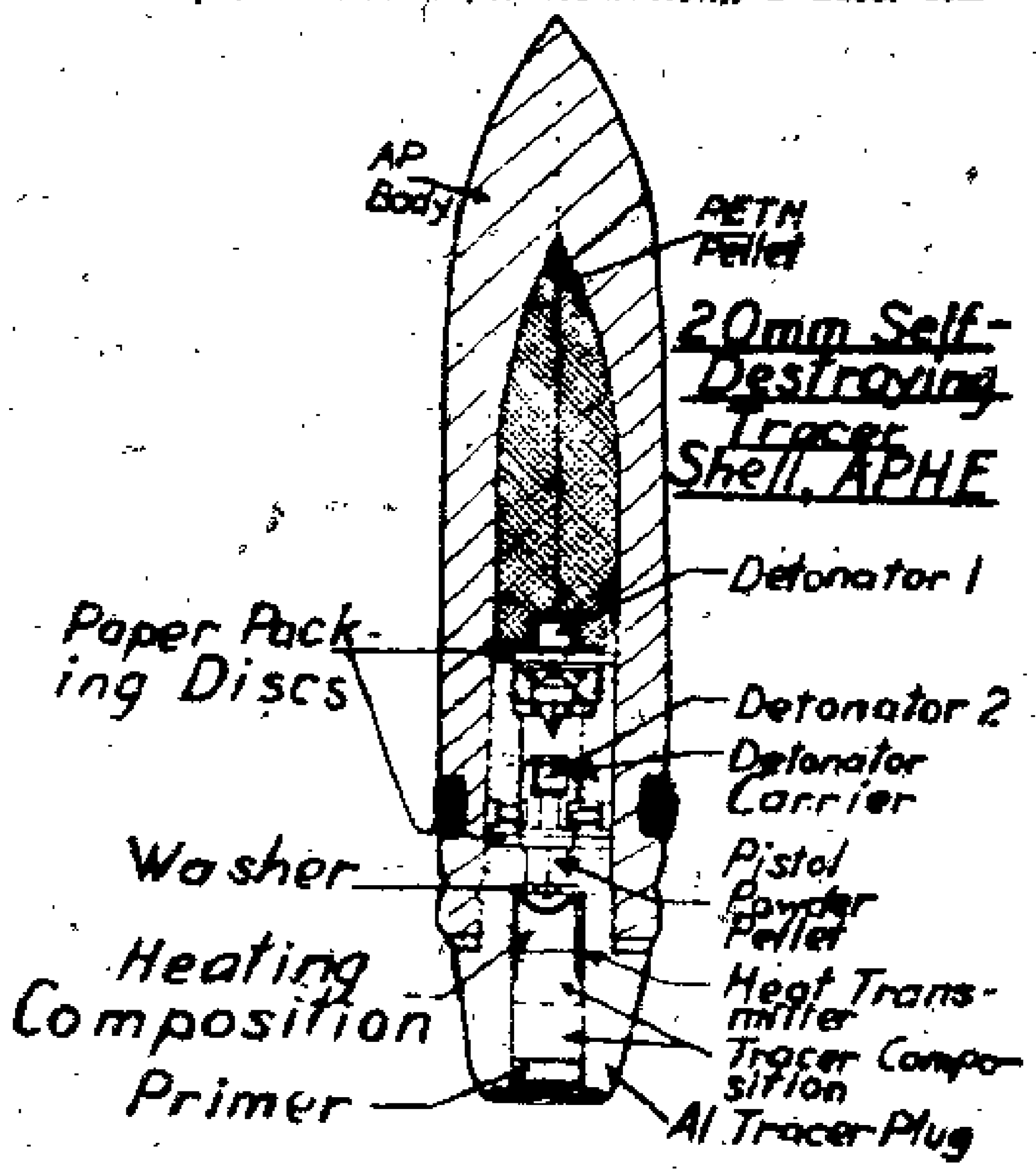
15%, whereas the pistol powder contained nitrocellulose with an ignition temperature of 160°. The bullet was self-destroyed (at 500-600 m range), because the heat produced by the burning of the last portion of tracer composition ignited a small charge of pistol powder, which in turn set off the HE charge. The primer composition was ignited by the propellant in the cartridge.
Reference: H.Peploe et al; CIOS Rept 33-20 (1945), pp 28-9.

Self-Destroying Tracer Shells, caliber 20 mm, developed by the Deutsche Waffen- und Munitionsfabriken A-G at Lübeck, included the following:

a) HE Shell for Aircraft Guns. It was of conventional design, and contained: a percussion fuze, a HE filling (PETN pellet), an incendiary pellet (Mg/Al alloy 50, Ba nitrate 49 and phenol formaldehyde resin 1%), a loose pistol powder (nitrocellulose), a pressed pistol powder, a heat transmitter, a tracer composition (two increments, each pressed at 3500-4000 kg/cm²) and a priming composition (pressed at 3200-3500 kg/cm²). If the shell was not exploded by the percussion fuze, it was self-destroyed after about 0.3 seconds of flight. At this moment the flame from the last portion of the tracer ignited the pistol powder which in turn ignited the incendiary pellet. The intense heat produced by the burning pellet caused the HE charge to deflagrate. The diameter of the tracer was 9 mm.



b) APHE Shell was of conventional design and contained: a HE filling (PETN pellet), two detonators, a pistol powder pellet, a heat transmitter, a heating composition (Ba nitrate 41.0, ferrosilicon 36.0, Ba peroxide 22.5 and phenol formaldehyde resin 0.5%), a tracer com-



position (two increments) and a primer composition with its surface sprayed with NC lacquer. The shell was designed to give a trace of 4.2-4.8 sec duration, to penetrate a 20 mm armor plate and to explode 30-50 cm behind it. If the shell was not exploded in the above manner it was self-destroyed by deflagration of the PETN pellet caused by the intense heat produced on deflagration of the pistol powder, which, in turn, was ignited by the heating composition. This composition was incorporated in the shell because the heat produced by the tracer alone was not sufficient to ignite the pistol powder owing to the small diameter (6 mm) of the tracer compared with the diameter of the HE shell (9 mm).
Reference: H.Peploe et al, CIOS Rept 33-20 (1945), pp 54-61.

Self-Igniting Cushion. See Brandkissen.

Self-Propelled (SP) Gun Mount [Selbstfahrlafette (Sf or Sfl)]. See under Panzer.

Sevastopol Gun. A mortar gun, caliber 800 mm, used effectively by the Germans during WW II at the siege of Sevastopol, Russia. The gun fired an 8 ton projectile with muzzle velocity of 2200-2400 ft/sec and maximum range of 29 miles. Weight of explosive was 2000 lb, wt of propellant 2500 lb, wt of gun 1375 tons and length of barrel 105 ft. It is probable that the propellant charge was contained in a cylindrical casing made of a propellant composition, as described under Made-Up Charges.

Note: This gun was nicknamed Dora or Gustav Geschütz (See also under Weapons).
References:
1) PB Rept 925 (1945), p 18
2) Aberdeen Proving Ground, Museum; private communication. Note: The projectile can be seen at the Museum.

"S" Geschoss. See Spitzgeschoss.

Shaped Charge or Hollow Charge. See Hohlladung in this section and Shaped Charge in the general section.

Sheathed Charge. See Mantelpatrone.

Shell. See Granate.

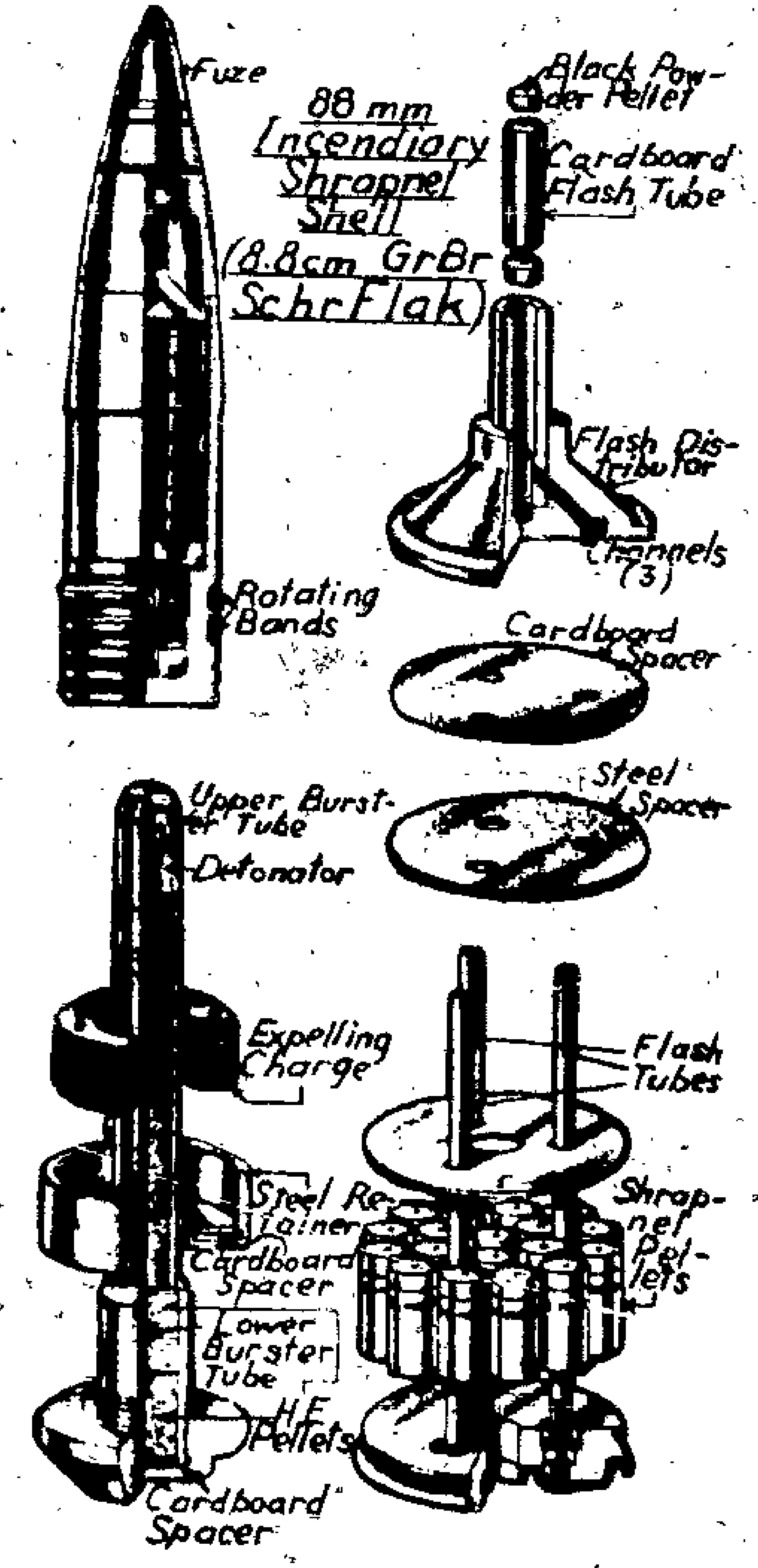
Shell Mold Process or "C" Process of Precision Casting of Metals (Called also Croning Process or Cronite Molding) developed in Germany during WW II by J.Croning, made possible the production of foundry molds and cores for cast metals in more intricate shapes and in larger sizes than were formerly considered practicable. In this process the thin shell molds were formed by the adherence of a mixture contg dry sand and plastics to heated metal patterns. Each shell mold was then hardened by further polymerization of the plastic bond by heating for a short time in an oven with a pattern still attached. After removal from the oven, the molds were stripped from the patterns, clamped together in pairs in a box, backed with loose metal shot or other porous material, and filled with molten metal for casting.

The process is applicable to the manufacture of shells, bombs, grenades and rockets.
References:
1) J.Croning, Ger Pat Application No 48679 (1949), described in PB Repts 83891 and 81284
2) B.N.Ames et al, The Foundry, August 1950, pp 92-96 and 206-17
3) H.L.Day, The Iron Age, 169, 28 (Jan 1952)
4) B.N.Ames et al, The Foundry, June 1952, pp 112-17 and 287-95
5) R.W.Tindula, PB Rept 106640r(1952) (47 references).

Shotgun or Sporting Propellant. See Jagdpulver.

Shrapnel Mine (Schrapnellmine, abbreviated as S-Mine, sometimes called Schützenmine). Two types, S-35 and S-44, are described in TM 9-1985-2 (1953), pp 279-81. The S-35 mine was called the Fruit Tin by the British. Owing to the fact that these mines rose into the air (to the height of 3 to 5 feet) before explosion, they were nicknamed **Bounding Mines** (See under Landminen).

Shrapnel Projectile (Schrapnellgranate). Only one such projectile, namely the 8.8 cm Granate Brand Schrapnell Flak (88 mm Incendiary Shrapnel Projectile for AA Guns) is described in TM 9-1985-3 (1953), p 448-49. The projectile consisted of a thin steel shell of conventional design containing: 72 incendiary pellets, a point detonating



time fuze (ZtZS/30 kurz), an expelling charge (about 2 oz of smokeless propellant) and a bursting charge (about .4 oz of TNT or Amatol and wax pressed pellets). The pellets were filled with an incendiary composition consisting of Ba nitrate 48.0, Mg alloy 24.6, Al alloy 24.6 and acid insoluble substances 2.8%.

Shrapnel Projectile, Russian. In addition to the previously mentioned shrapnel projectile, the Germans, during WW II, used the 76.2 mm Shrapnel Projectile, 42M, captured from the Russians. The shell was filled with about 48 triangular pieces of steel, 2.25" long, which were ejected from the nose by a steel forcing plate behind which was a charge of black powder. The threads and the two retaining screws

of the collar were sheared by this action. The shell was fired from Russian field guns 7.62 cm FK 296(r) and 7.62 cm FK 36(r).
Reference: Anon, German Artillery Projectiles and Fuzes, Ordnance Bomb Disposal Center, Aberdeen Proving Ground, Maryland (about 1945), pp 120-1.

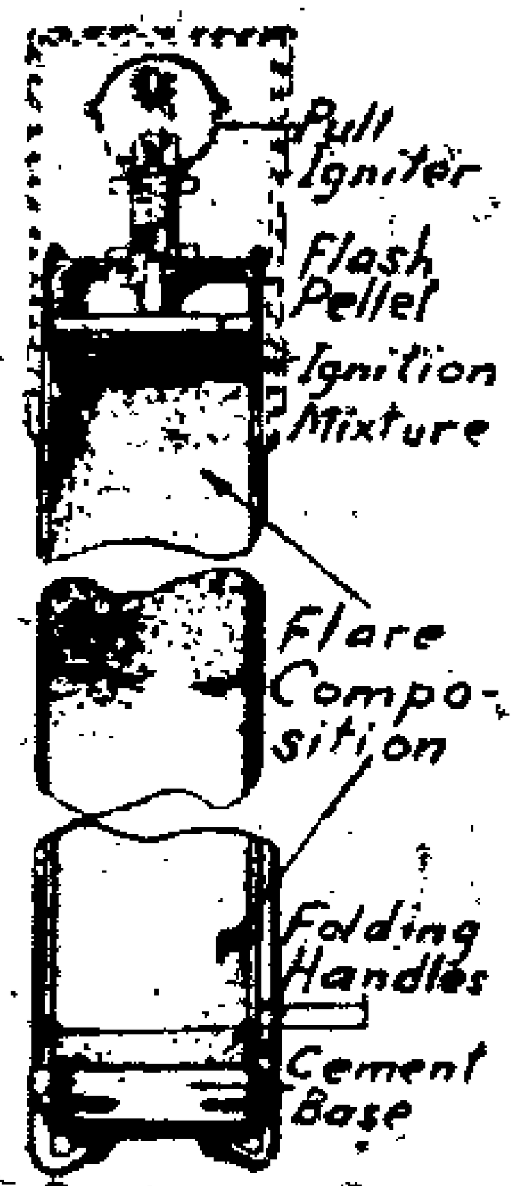
SH-Salz. The term used for RDX (Hexogen) prepared by the direct nitration of hexamethylenetetramine as described briefly in this section under Hexogen.

Sicherheitsdynamit (Safety Dynamite). According to Stettbacher, Spreng- und Schiesstoffe (1948), p 86, the dynamites which are safe to handle and transport are called Handhabungssichere and those of them which are safe to use in coal mines are known as Sicherheitsdynamite. The latter dynamites contain 20-25% of NG (or a low-freezing mixture of NG and nitroglycol-4/1, mixed with dinitrochlorohydrin which serves as a phlegmatizer) and a "dope", such as Am nitrate, wood meal, etc. If the NG is phlegmatized by means of collodion cotton, the resulting dynamite belongs to the Gelatinedynamite class, such as the Ammongelatine. Note: In countries other than Germany, for example France and Switzerland, aromatic nitrocompounds, such as DNT, TNT, etc, were used as phlegmatizers in lieu of dinitrochlorohydrin. Such dynamites were known as Nitrogelatindynamites.
(See also under Swiss Explosives).

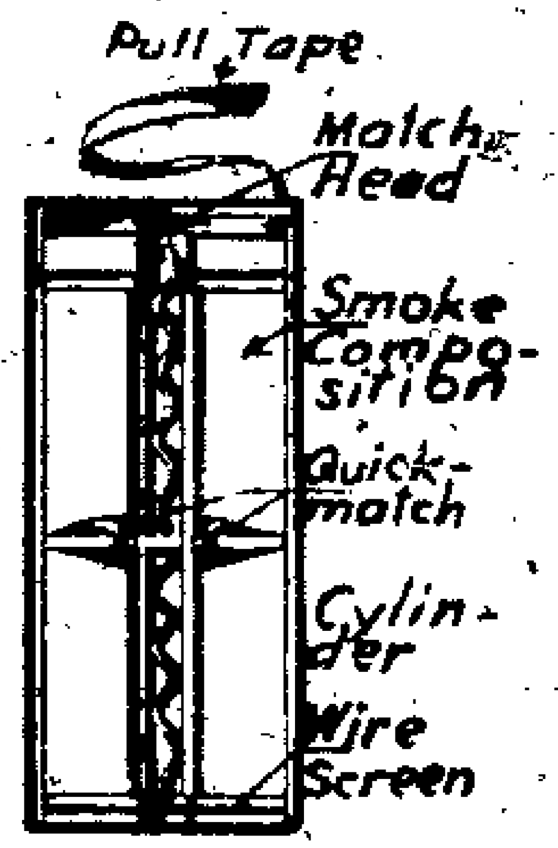
Sicherheitssprengstoffe (Safety Explosives). According to Stettbacher, Spreng- und Schiesstoffe (1948), pp 86-7, explosives under this name were allowed to be transported by rail. They contained 70-90% Am nitrate and not more than 4% NG, the remainder being wood meal, aromatic nitrocompounds, etc. These explosives, known also as Ammonsalpetersprengstoffe were pulverulent, very insensitive to impact, fairly stable and difficult to ignite. An example of such explosives is Donarit. Most of the Sicherheitssprengstoffe are also Schlagwettersichere (safe to use in coal mines contg firedamp).
(See Wettersprengstoffe, pages 226 and 260-2, and also Schlagwettersichere Sprengstoffe).

Signal Device (Signalmittel). Under this term might be included: Hand Smoke Signal (Handrauchzeichen), Signal Cartridge (Signalpatrone), Signal Flare (Signalbombe), Signal Hand Grenade (Signalhandgranate), Signal Pistol (Leuchpistole, Kampfpistole), Signal Projector (Signalwerfer), Signal Rocket (Signalrakete) and Signal Torch (Signalfakel). Many of the signal items are either described or mentioned in TM 9-1985-2 (1953), as for instance the following:

a) Smoke Signal Flare (p 80), is also briefly described under Flare.
b) Smoke Signal Flare ARDR (p 80) is also briefly described under Flare
c) Distress Signal Torch (p 81) consisted of a sheet aluminum cylinder containing three pressed blocks of a flare composition and a pull igniter with a flash pellet and an ignition composition
d) Red Smoke Signal Hand Grenade (Handrauchzeichen-Wurf) (p329) consisted of a cardboard cylinder containing 34 g of the red smoke composition [ortho-methoxy phenylazo-β-naphthol 55, K chlorate 20, lactose 10 and light oily material (unidentified) 15%], a black powder disc, a quickmatch, a match head and a pull tape. By striking the striker ring on the match head, the quickmatch was ignited and after it burned the



Distress Signal Torch



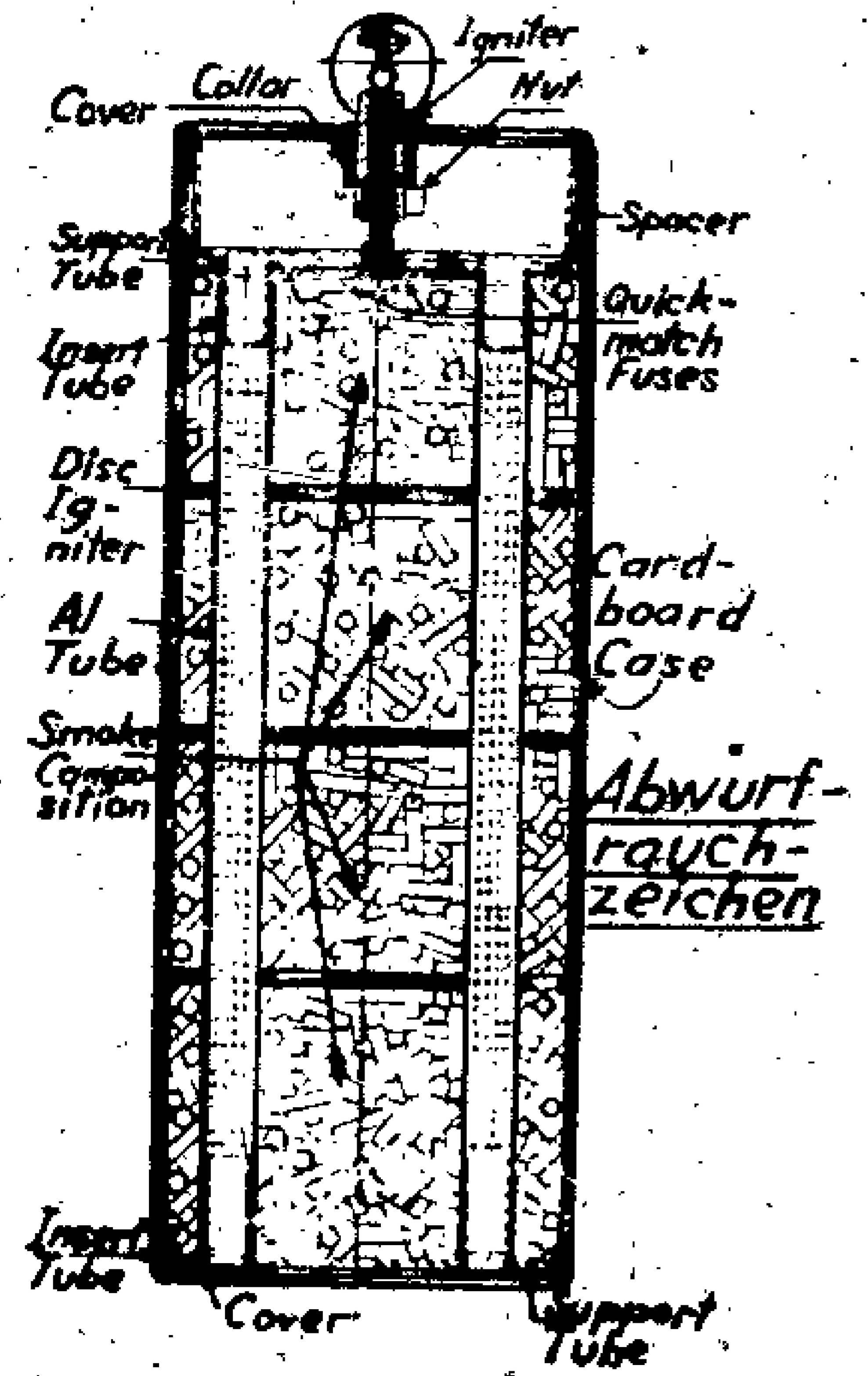
Red Smoke Signal Hand Grenade

entire length the black powder disc was ignited. The flame was then communicated to the smoke mixture which started to burn emitting the smoke at both ends of the cylinder. The signal could be placed or thrown. There were also similar orange, yellow and violet signals.
e) Hollow Charge Signal Pistol Grenade (p 344) is described under Pistol Grenades
f) Multistar Signal Cartridge (p 345) is briefly described under Pistol Grenade.

Some of the smoke compositions used in Hand Signals (Handrauchzeichen) are listed under Pyrotechnics.

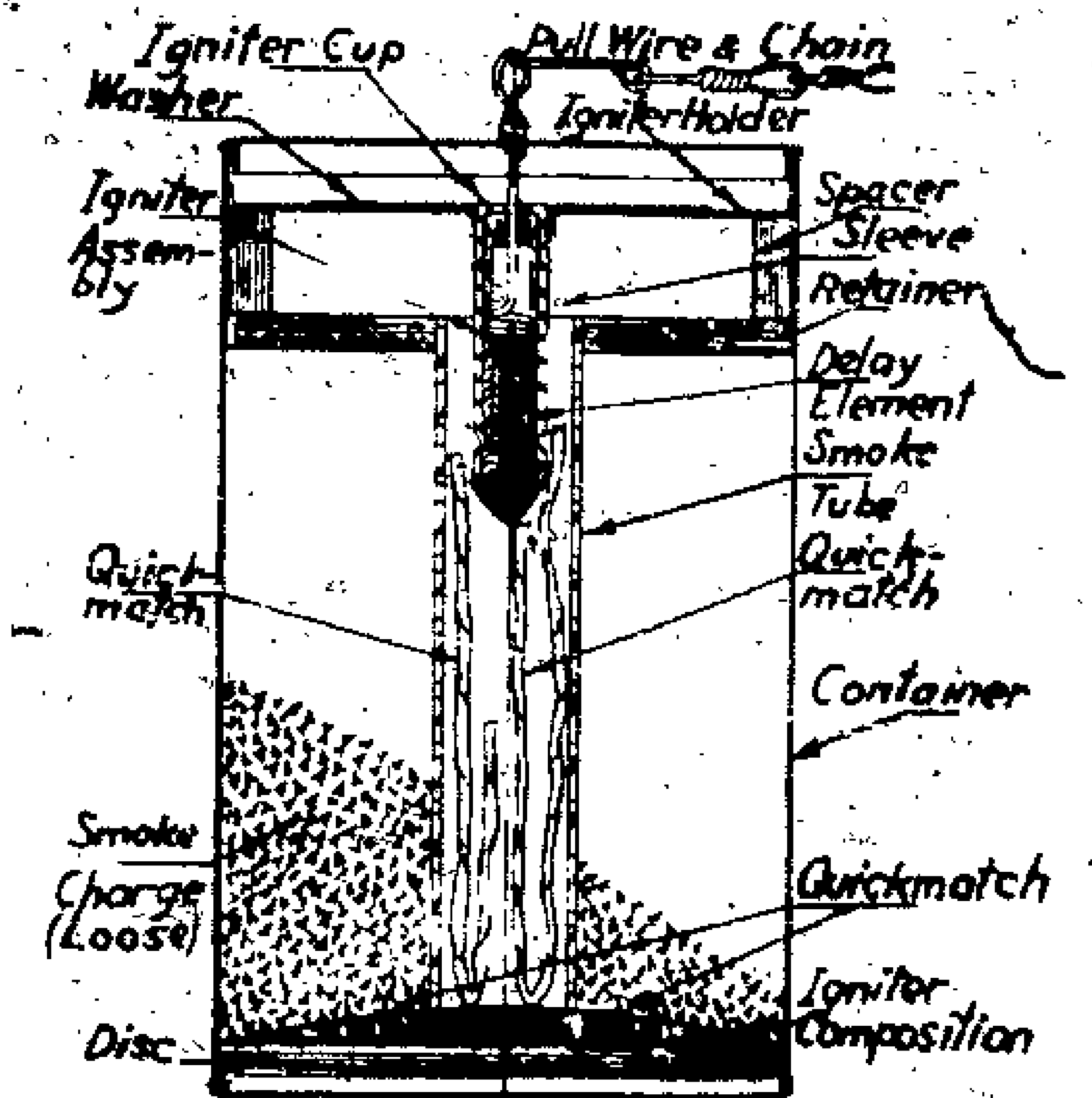
A smoke signal generator, designated as RSSGs Patrone 15 cm RZ is described in CIOS 32-13 (1945), p 14. The device consisted of a pasteboard cylinder enclosing 1.4 kg of smoke composition containing Hexa (hexachloroethane) 52.5, Zn dust 38.0, ZnO 4.0 and Mg powder 5.5%. The time of emission was 45 to 75 seconds. This device appears similar to the 150 mm Rocket Signal Simulating Device (15 cm Raketen Scheinschuss Gerät) described in CIOS Rept 32-56 (1955), pp 3-5 and in this section under Antipathfinder Pyrotechnic Devices.

F.G.Hayerlack in Picatinny Arsenal Technical Report 1505 (1945), described the Aircraft Colored Smoke Signal (Abwurfrauchzeichen). This consisted of a cardboard cylinder covered with an aluminum cap and containing four increments of a colored smoke mixture, four perforated aluminum tubes serving as smoke stacks and a firing device assembly. The smoke composition (which on heating gave either blue, red or violet colored smoke) consisted of approximately 50% organic dye, 21% lactose, 21% K chlorate, 3% binder (gum) and 5% insolubles in water (SiO_2 dirt, etc). The device was fired by pulling the cord attached to the firing pin spring thus allowing the pin to strike the priming cap. This fired 0.015 g of a mixture of K chlorate

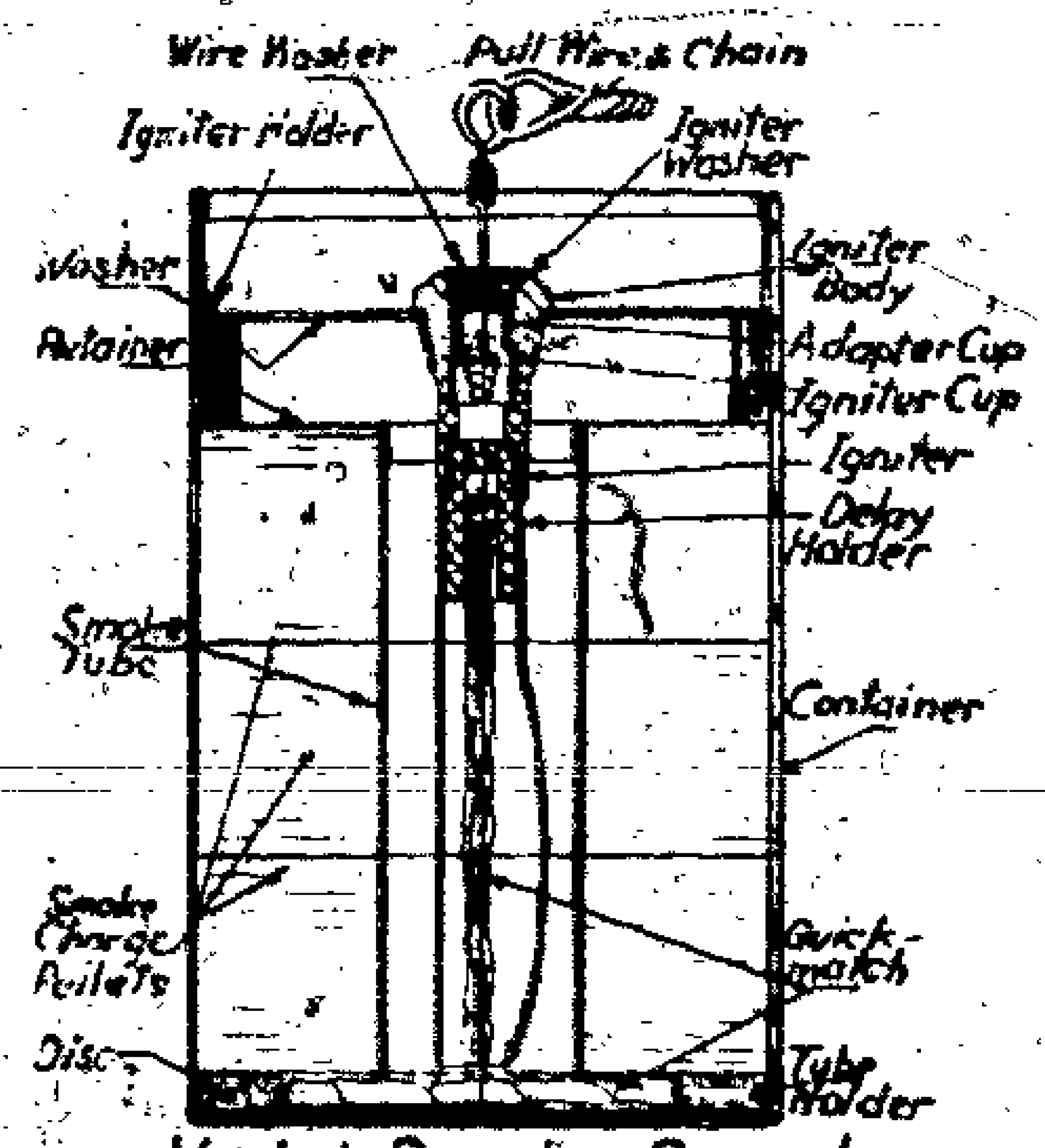


and mercury fulminate which ignited the delay element which consisted of an upper charge (0.060 g of mixture: K nitrate 75, charcoal 15 and sulfur 10%) separated by a perforated lead disc from an intermediate charge (0.030 g of ground colloided nitrocellulose) and a lower charge (0.030 g of K nitrate 73, charcoal 17 and sulfur 10%). After burning for about 1 second the flash was transmitted to the quickmatch composition (black powder) located in the center of the top igniter disc. This center charge transmitted the fire to the "cross" of quickmatch composition on the underside of the top igniter disc and in turn, to the quickmatch fuses (K nitrate 78, charcoal 13 and sulfur 9%), both of which caused ignition of the top layer of the smoke charge. The heat and pressure of the generated gases burned through the paper coverings on the four tubes and dislodged the paper discs (over four ¼" diameter vents in the top cover of the body) thus allowing the smoke to escape outside. Upon completion of burning of the first increment of the smoke charge, the fire was transmitted through another igniter disc (by means of the quickmatch composition in its center) to the second increment and so on. It should be noted that the 2nd, 3rd and 4th discs did not have the "cross" of the quickmatch composition present.

The same investigator, in Pic Arsn Tech Rept 1519 (1945), described the Hand Smoke Signals emitting colors: green, red, violet and blue (Handrauchzeichen Grün, – Rot, – Violett und – Blau). The signal body was a sheet steel cylinder averaging 3 5/16" long by 2" in diameter, with fixed bottom and removable cover which was held in place by a strip of adhesive tape. Each cylinder contained a smoke composition (loose grains for the red signal and four compressed cylindrical blocks with central hole for the green, blue and violet signals). In the center of each smoke mixture was located (except for the green signal) a sheet metal tube provided with small perforations. (The green signal had no tube but a cylindrical cavity extending through all four blocks of the smoke charge). The lower end of the tube was attached to the bottom of the cylinder, whereas the upper end was inserted through the bottom of a shallow cup-shaped igniter holder which supported the friction igniter assembly to which a pull chain and ring were attached. The lower part of the igniter



Red Smoke Signal



Violet Smoke Signal

assembly, which included the delay element, was extended into the centre perforated tube. Below the igniter, inside the central tube, were located loose pieces of quickmatch (black powder) used to facilitate the ignition of a smoke charge.

Note: In the green signal the pieces of quickmatch were located in the cavity.

Following were the compositions of smoke mixtures:

	Green	Blue	Red	Violet
Organic dye	45.0	44.7	33.7	48.7
Lactose ($C_{12}H_{22}O_{11} \cdot H_2O$)	24.7	23.5	23.7	17.7
K chlorate	28.5	23.0	17.8	26.4
Insolubles in H_2O (SiO_2, Fe_2O_3, Al_2O_3, etc)	—	7.3	1.8	3.6
Binder (by difference)	1.8	1.5	3.0	3.6
Weight of charge (in grams)	23.9	31.5	27.0	28.6

The signal was fired by removing the cover, pulling quickly on the igniter chain (by means of the pull ring) and then throwing the signal (or placing it upright on the ground). The friction wire being pulled through 0.04 g of the composition: antimony sulfide 50, potassium chlorate 30 and mercury fulminate 20%, caused it to flash and to ignite, in turn, the delay element (0.05 g of K nitrate 75, charcoal 16 and sulfur 9%). After burning for about 1½ seconds, the flame from the delay element ignited two cords of quickmatch (black powder) which, in turn, ignited the black powder composition (1.3 to 1.8 g) on the bottom igniter disc and finally the smoke mixture. The smoke from the burning charge was forced through the small holes in the central tube (or in the central cavity in the case of the green signal), and thence around the friction igniter, and through the hole in the retainer into the space between the retainer and igniter holder. The heat and pressure of gases generated on burning ruptured the film covering the six vent holes in the igniter holder thus allowing the smoke to escape. It was assumed that the smoke charge burned from the center outward and from the bottom upward. The duration of emission of smoke was 12 to 20 seconds.

Signal Smoke Device. See Signal Device.

Silesia-Sprengstoffe (Silesia Explosives) were chlorate explosives developed before WW I by the Oberschlesische A-G für Fabrikation von Lignose (Schiesswollfabrik für Armee und Marine). According to Escales (Ref 1, p 185) one type of Silesia was a mixture of K chlorate 80 (max) with 20% resin of which 4% could be in the nitrated state. Another composition contained K chlorate 75 (max) resin 8(minim) and Na chloride 10% (minim). The resin had a m p of about 70° and the Na chloride was mixed with 1 to 4% of its weight of paraffin oil.

Following were the compositions of some of these explosives:

a) Silesia IV: K chlorate 70, resin 8 and Na chloride 22%; it was suitable for blasting rocks and ores, but not for use in gaseous coal mines (Ref 1)

b) Silesia No 4: K chlorate 80 and resin 20%; it was suitable for blasting rocks and ores, but could not be used in gaseous or dusty coal mines (Ref 2 & 3).

References: -

1) R.Escales, Chloratsprengstoffe, Veit, Leipzig (1910), pp 143 & 185

2) A.Marshall, Explosives, Churchill, London, v 1 (1917), pp 382-3

3) E.Barnett, Explosives, Van Nostrand, N Y (1919), p 111.

Silver Azide (Silberazid) (Ag A). See general section under Azides.

Silver Fulminate (Silberfulminat). See general section under Fulminates. It was used in Germany as a primary charge in the Ansamitkapsein (q v).

Silvit oder Pikrit (Silvite or Picrite). A type of blasting explosive prepd by mixing pulverized picric acid (left over from WW I) with 5 to 10% of aqueous molasses or cellulose pitch, a tarry product obtained by evaporating sulfite liquor from the pulp industry. The composition could contain up to 20% of aromatic nitrocompounds such as TNT, DNB, etc.

References:

1) P.Naoúm, Schiess- und Sprengstoffe (1927) p 66

2) J.Pepin Lehalleur, Poudres, etc (1935), pp 457-8.

Sinoxydsatz oder Synoxyd. Primary explosive mixture developed in Germany about 1930 to replace previously used mercuric fulminate compositions. It has been claimed that the products of decomposition of Sinoxyd are non-corrosive and do not erode firearms. Ficheroulle and Kovache (Ref 3) give the composition of a mixture used by the Germans during WW II as follows: lead styphnate 25 to 55, tetracene 1.2 to 5, Ba nitrate 25 to 45, PbO_2 5 to 10, Sb_2S_3 0 to 10, Ca silicide 3 to 15 and powdered glass 0 to 5%.

References:

1) E. von Herz, S S 28, 39 (1933), Die erosionsfreie Zündung

2) A.Stettbacher, Spreng- und Zündstoffe, Zürich (1948), pp 98 & 106-7

3) H.Ficheroulle, A.Kovache, Mém poud 31, 26-27 (1949).

Sintered Iron and Steel Items, such as bullets, pyrotechnic devices, etc, are mentioned under Pulvermetallurgie.

Sintered Iron Projectiles. See under Tiefbohrer Verfahren.

Ship Bomb or Kurt Apparatus, designated as SB 400 Kugel K is described on p 14 of TM 9-1985-2 (1953). (See also under Bombe).

Small Arms (Handfeuerwaffen). See under Weapons.

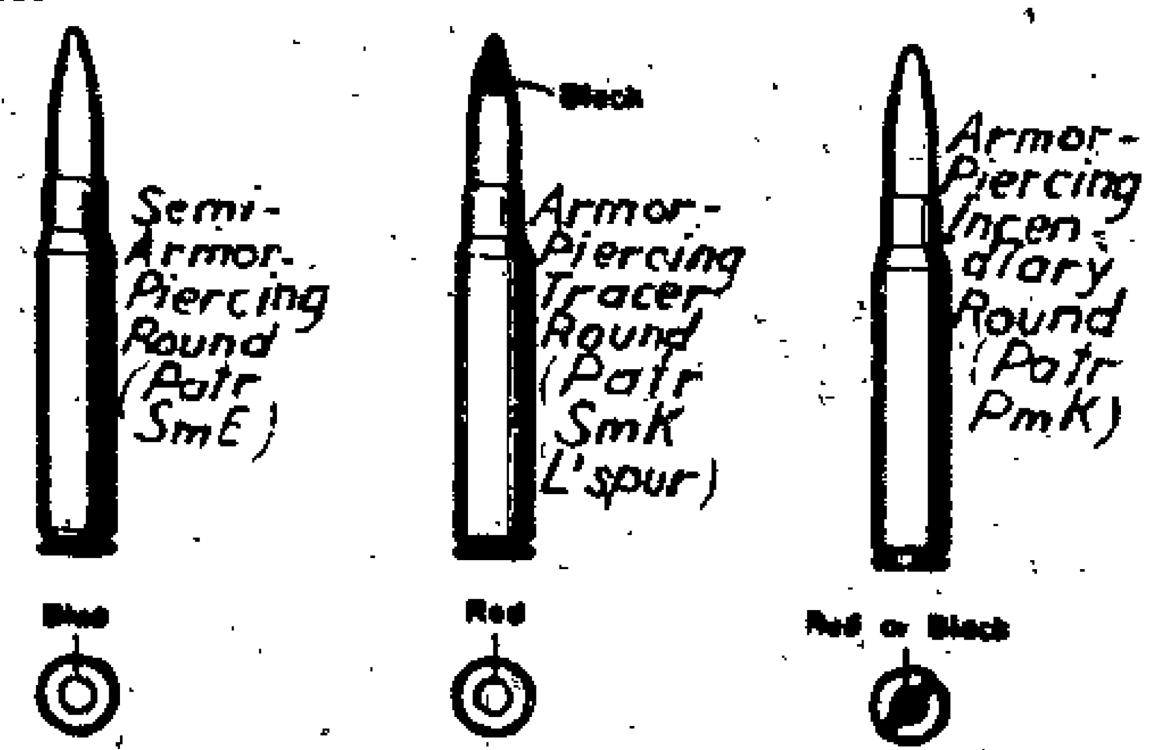
Small Arms Ammunition. According to A.J.Dere, Ordnance Sergeant, December 1943, pp 357, the German small arms ammunition was similar to American. The complete round consisted of a cartridge case, percussion cap (primer), propelling charge, and bullet. The cartridge was drawn either from sheet brass (copper 72 and zinc 28%) or from sheet steel, copper plated on both sides. The case was bottle shaped, grooved at the base and coned slightly to facilitate extraction. A primer pocket was formed in the base of the case and was connected to the interior by flash channels. In the center of the pocket an anvil was formed on which the primer composition was fired by the firing pin. The primers were of the Berdan type, either the No 88 or No 30. The No 88 primer consisted of a brass cup containing the primer composition, and a covering cap of double-size zinc-plated lead foil. The primer composition was put into the cup dry and was protected from dampness by the cap which was lacquered on the inside. The inside of the cup was also lacquered to the level of primer composition. The No 30 primer was essentially the same as the No 88 except that its primer composition was different and practically non-erosive. A charge of a typical small arms cartridge consisted of a single-base (nitrocellulose) propellant in blackish, square, graphite-treated flakes about .25 mm thick and 1.2 to 1.5 mm long, with smooth-cut surfaces. A typical bullet had a boat-tail base and consisted of a lead core and jacket consisting of either cupro-nickel, gilding metal or copper-plated steel. There were also bullets with steel cores or made entirely of steel (See under Steel and Iron Ammunition Items). The bullet was crimped to the cartridge case in the conventional manner by means of a cannelure.

The following calibers were commonly used during WW II.

A. 7.92 mm Ammunition which can be subdivided into the following types:

a) Patr sS (Patronen schweres Spitzgeschoss), Heavy Pointed Ball Ammunition, had a bullet with a lead core and a copper-alloy jacket. The annulus on the base of the cartridge was painted green. If labeled as simply Patr sS, the ammunition could be used either in rifles (such as Mauser or Gewehr 41) or in machine guns (such as MG 15, MG 17, MG 81, MG 34 and MG 42). In the same weapons could be used ammunition with label "Patr sS iL", in which the letters "iL" indicated that the rounds were clip packed. The label "Patr sS für Gew" indicated that the rounds were designed for use in rifles and the label "Patr sS für MG" indicated that the rounds were designed for use in machine guns

b) Patr SmK (Patronen Spitzgeschoss mit Stahlkern), Armor-Piercing Ammunition had a bullet somewhat longer than in (a). The core was of steel and the jacket of steel with gilding metal coating. The annulus was painted red



c) Patr SmKH (Patronen Spitzgeschoss mit Stahlkern Gehärtet), Armor-Piercing (Super) Ammunition, had a bullet with a tungsten carbide core and a steel jacket coated with gilding metal. The bullet was painted black and the annulus was red

d) Patr SmE (Patronen Spitzgeschoss mit Eisenkern), Semi-Armor-Piercing Ammunition, was similar to the above, except that the core was of soft steel or iron. (See also under Steel and Iron Ammunition Items)

e) Patr SmK L'spur (Patronen Spitzgeschoss mit Stahlkern und Leuchtspur), Armor-Piercing-Tracer Ammunition, had a bullet with a steel core and lead point filler enclosed in a copper-plated steel jacket. The tracer was usually green changing to red. The point of bullet was painted black and the annulus red. This round was used principally against aircraft

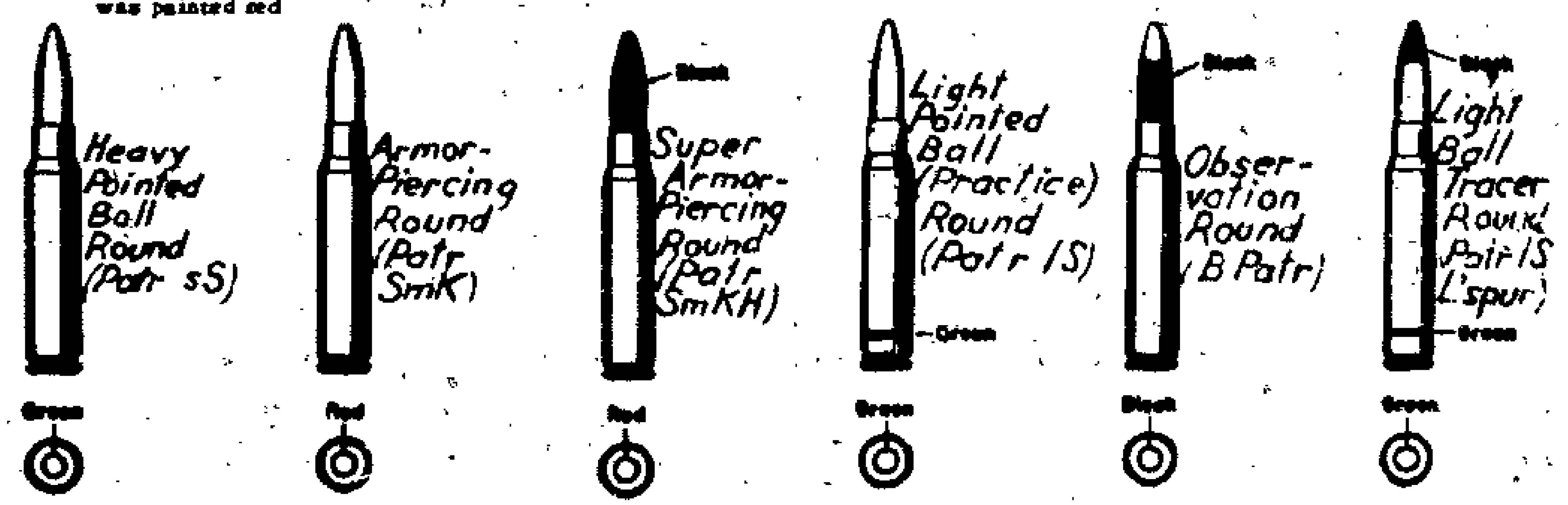
f) Patr PmK (Patronen Phosphor mit Stahlkern), Armor-Piercing-Incendiary Ammunition, had a bullet with a steel core and a phosphorus filling. It was used against aircraft and on striking the target a trace of white smoke was evolved. The annulus was painted either red or black and sometimes the case had a red band across the base

g) Patr lS (Patronen leichtes Spitzgeschoss), Light Pointed Ball Ammunition, had a bullet with an aluminum filling. This round was used for antiaircraft practice

h) B Patr (Beobachtungsgeschoss Patronen), Observation Ammunition had a bullet with a core of high explosive, a fuze in the central portion of the bullet, and a phosphorus filler in the base. It was an observation round, the purpose of which was to indicate by means of a puff of smoke the spot where the target was hit. The bullet was painted black except its tip.

Note: This bullet is described more fully under Observation Bullet. According to CIOS Report 33-20 (1945), p 18, it was also adopted as an incendiary bullet for use against aircraft.

i) Patr lS L'spur (Patronen leichtes Spitzgeschoss mit Leuchtspur), Light Ball-Tracer Ammunition, had a bullet with an aluminum filler and a tracer (white).



This ammunition was used in antiaircraft practice. The tip of the bullet was painted black.

j) **Patr. 318Rs** (Patronen 318 Reizstoff), Antitank Rifle Ammunition which contained a small charge of harassing agent. It had a very large cartridge case and an armor-piercing bullet. There were two types of this ammunition, one used in the Polish Antitank Rifle and the other used in its German copy, the PzB 39 (Panzerbüchse 39). The Polish round was much smaller than the German which was marked 7.92 mm/13 mm.

Note: According to CIOS Rept 33-20 (1945), pp 17-18, the Germans also developed two other tracer bullets, designated as SmKL'spur (Di) and SmKL'spur (Gl). There was also the SmKL'spurnZ, described in this German section under Self-Destroying Tracer Bullet.

B. **9 mm (.354") Ammunition** could be subdivided into the following types:

a) **PistPatr 08** (Pistolen Patronen 08), Ball Ammunition, had a bullet with a lead core and a jacket either of cupro-nickel or gilding metal.

b) **PistPatr 08 mE** (Pistolen Patronen 08 mit Eisenkern), Semi-Armor-Piercing Ammunition which had a bullet with a mild steel core and lead point filler. The jacket was of steel coated with gilding metal.

Note: Each of these rounds could be used in the following weapons: Luger (Parabellum) Pistol, Schmeisser Carbine, Walther Automatic Pistol, Bergmann Submachine Gun and Steyr-Solothurn Submachine Gun.

C. **13 mm (.51") Ammunition** could be subdivided into the following types:

a) High Explosive-Tracer Ammunition had a bullet containing some PETN as a bursting charge, a point detonating fuze and a tracer composition. The bullet was painted yellow

b) High-Explosive-Incendiary-Tracer Ammunition had a bullet containing the same ingredients as above plus the incendiary composition. The bullet was painted yellow with a blue band

c) Tracer Ammunition had a bullet containing the tracer composition, giving either a white or green trace. The bullet was painted green with a white band

d) Armor-Piercing-Tracer Ammunition had the bullet painted black with a yellow band. The trace was pale green.

Note: The above ammunition was used in the Rheinmetall-Solothurn Fixed Aircraft Cannon MG 131.

D. **15 mm (.59") Ammunition** could be subdivided into the following types:

a) High-Explosive-Tracer Ammunition had a bullet containing a PETN/Wax filler, a brass fuze (AZ 1551) and a tracer. The bullet was yellow with a black band in front of the driving band

b) High-Explosive-Incendiary-Tracer Ammunition had a bullet containing the same ingredients as above plus the incendiary pellet. The bullet was yellow with a blue band

c) High-Explosive-Tracer-Self-Destroying Ammunition had a bullet similar to (a) but provided with a self-destroying device. The bullet was painted yellow

d) Tracer Ammunition had the bullet painted olive green with a yellow band in front of the driving band

e) Armor-Piercing-Tracer Ammunition had the bullet painted black. Sometimes a yellow band was painted in front of the driving band.

Note: The above ammunition was used in Mauser Fixed Aircraft Cannon MG 151-15.

Although the ammunition of calibers 20, 25, 27, 28/20 and 30 mm was considered by the Germans as belonging in the small arms category, it is not included by us in this section because when this work was conceived, US practice classified these items as artillery ammunition. [See T.C.Ohart, Elements of Ammunition, Wiley, NY (1946), p 3], and only items of caliber 0.60" (15.24 mm) or smaller belonged to the small arms category.

It should be noted, however, that quite recently (fall of 1955) the US classification was changed and the calibers 20 mm and 30 mm are now included in the category of small arms.

Small Explosive Bodies. According to W.Dornberger, V-2, Viking, NY (1954), p 270, these were explosive devices suspended on wires 250 yd long attached to parachutes. They could be dropped from a plane ahead of enemy bomber formations, thus forming an effective floating barrage. The units which were not exploded eventually came to earth.

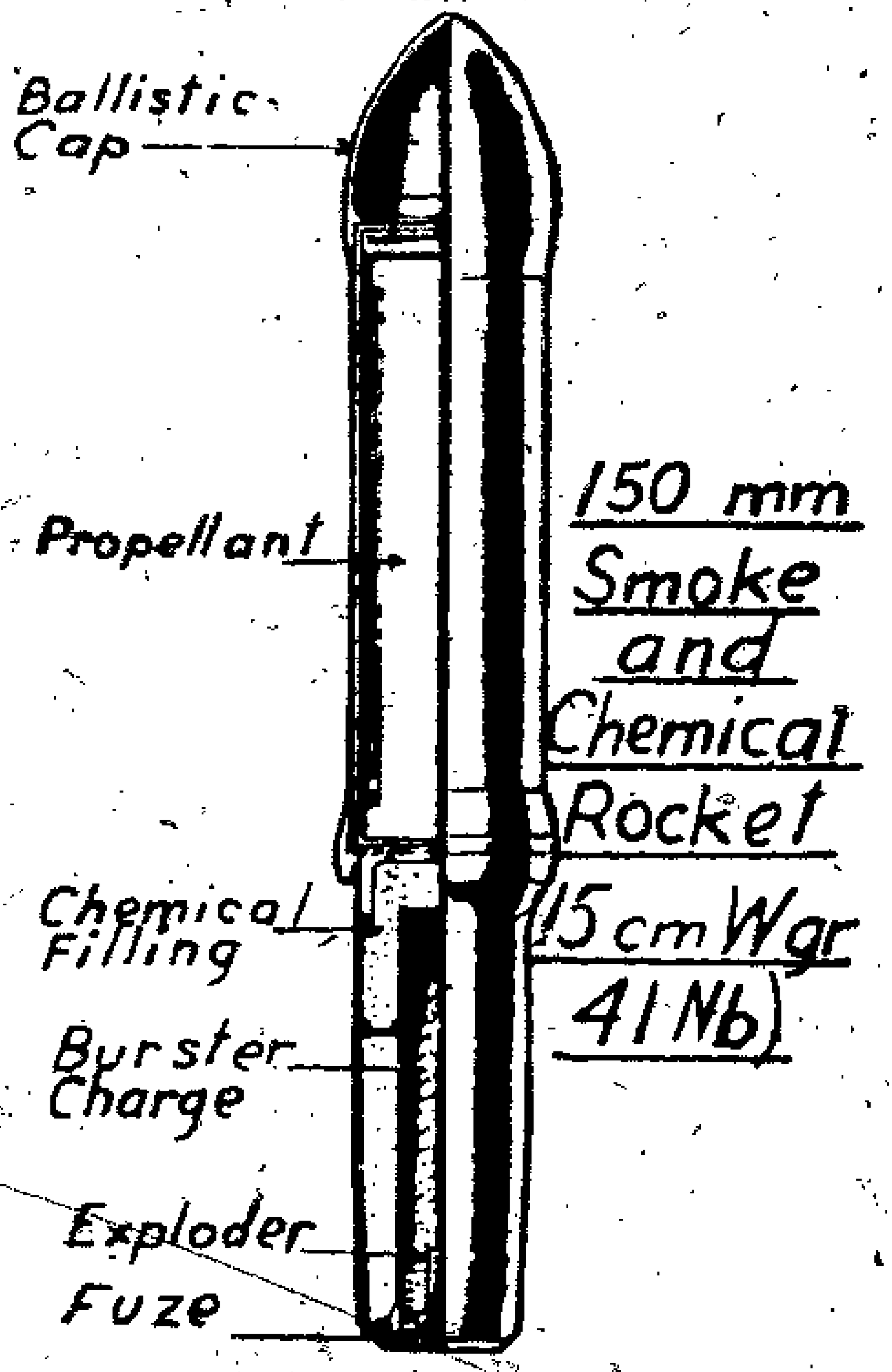
Small Generator was a training device consisting of a sheet metal box with a press on lid. The box contained a heating composition (such as the one consisting of Ba peroxide, Ba nitrate, Fe powder and kieselguhr) above which was pressed a chemical warfare agent (CWA) (such as chloracetophenone, Clark II, mustard gas or thiophosgene) absorbed on kieselguhr.

Reference: E.W.Bateman, CIOS Rept 32-13 (1948).

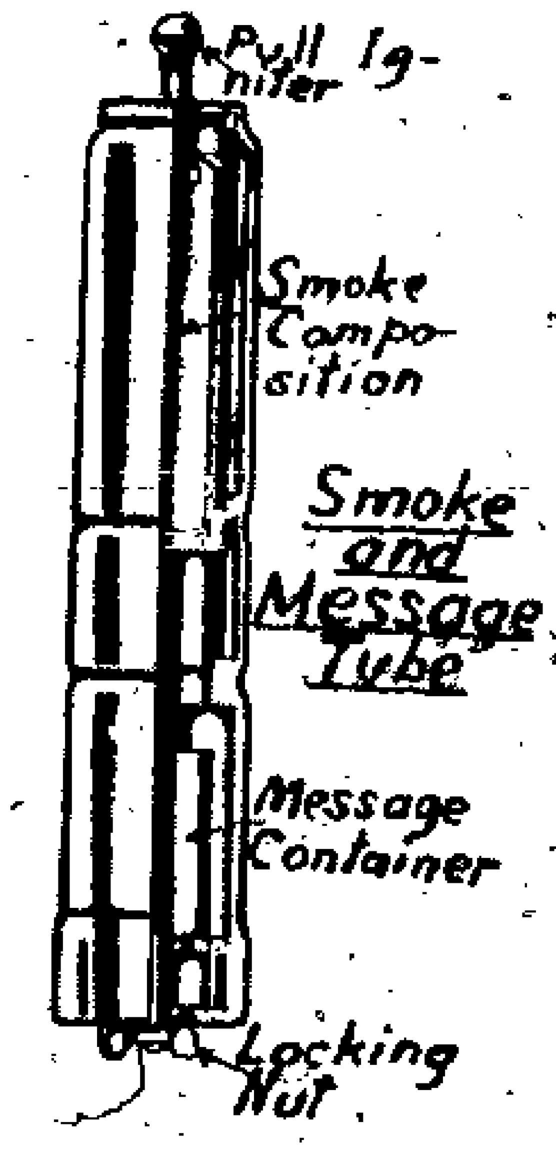
S-Mine 35, **S-Mine 42**} See TM 9-1985-2 (1953), pp 279-80 and also under Landminen.

Smoke and Chemical Rocket, 150 mm, Spin Stabilized (15 cm Wgr 41Nb), resembled in appearance an elongated gun projectile and was provided with a bulbous nose cap. The body consisted of a thin-walled steel cylinder housing a rocket motor (seven single-perforated double-base propellent grains, weighing 14 lb) threaded at the base to receive a cylinder containing a smoke (or chemical) composition, a bursting charge (1.05 lb of picric acid), an exploder and a base fuze. The smoke composition (not specified) was located between the outer wall of the shell and the outer wall of the burster container. The weight of smoke filling was about 8 lb and the total weight of the rocket 79 lb. The smoke composition was ignited after the shell hit the target.

Reference: TM 9-1985-2 (1953), pp 245-7.



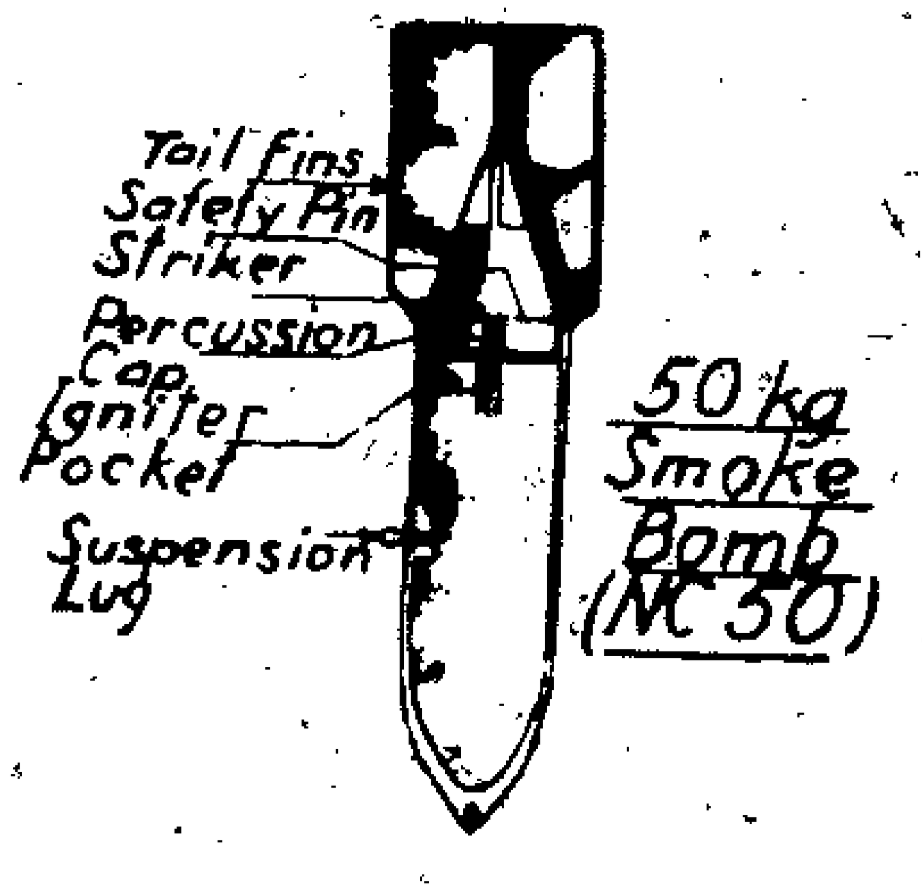
Smoke and Message Tube, described in TM 9-1985-2 (1953), pp 120-1, consisted of an aluminum cylinder housing in its upper section some reddish-brown smoke composition (giving very bright yellow smoke) and in its lower section a message container. The top cover of the cylinder held the friction igniter (1 second delay) and through a hole in the cup-shaped aluminum piece near the cover protruded the ends of four strands of quickmatch. These strands were located on the side of the smoke container and met several pieces of fire quickmatch below the smoke container. The smoke container was 5" long, 1.75" diameter and weighed 10.5 oz.



Smoke Bomb, Cylindrical (Nebelcylindrische Bombe, abbreviated as NC). Smoke bombs were usually of conventional appearance. They were provided with a fuze (usually mechanical), which ignited a smoke producing composition.

The following types are described in TM 9-1985-2 (1953), pp 58-60.

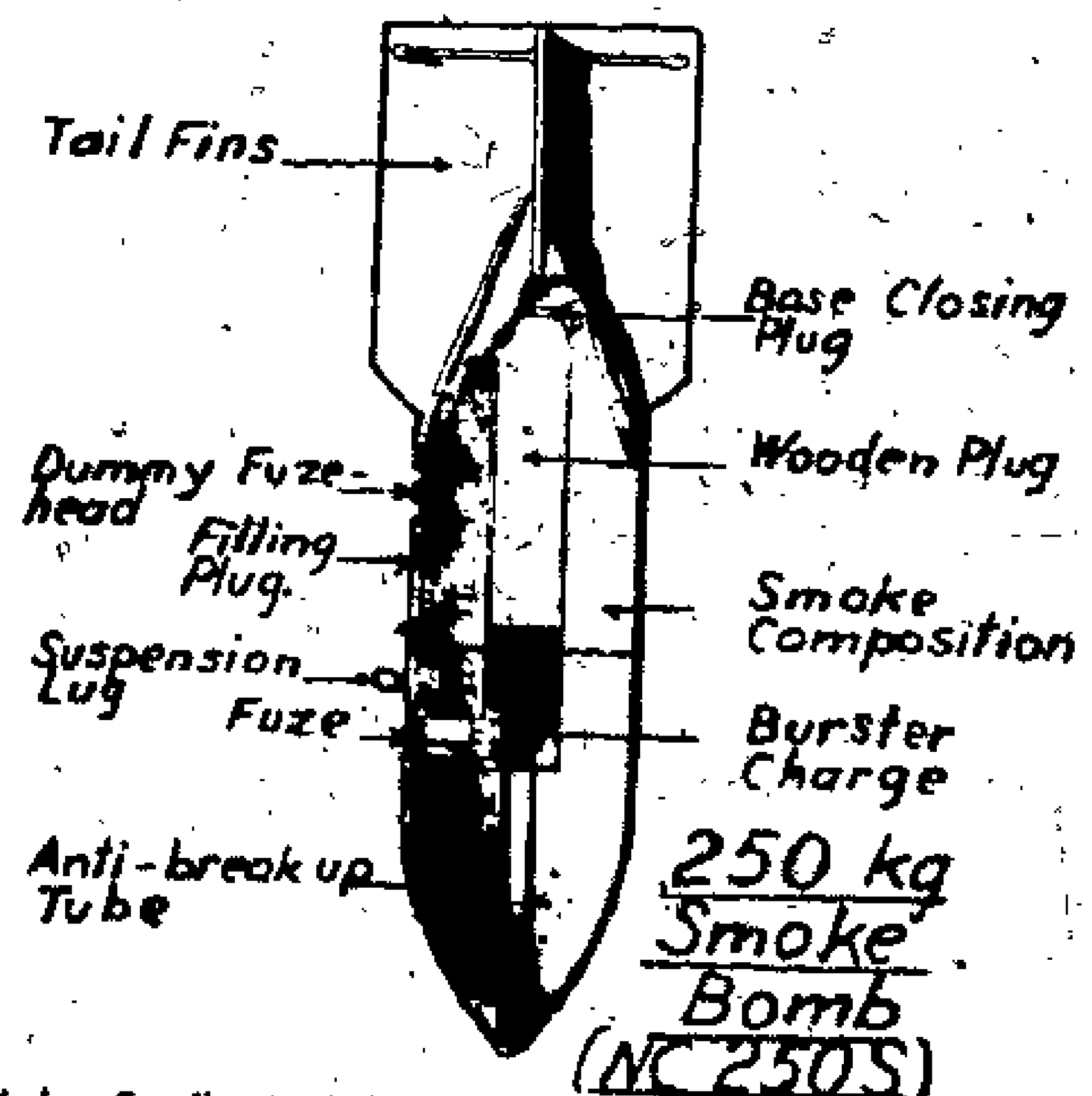
a) **NC 50** (Smoke Cylindrical 50 kg) consisted of a seamless steel cylinder (body) with a cast steel nose welded to it. At the rear end were four tail fins. The body was filled with a light grey smoke producing powder (smelling strongly of camphor). A mechanical impact fuze was located in the rear section of the bomb. Total weight of the bomb was 109 lb, body diameter 7¼", body length 10¾" and over-all length 26¾"



b) **NC 50 WC** (Smoke Cylindrical 50 kg Marker Bomb) See under Marker.

c) **NC 50 D/See** (Smoke Cylindrical 50 kg Floating Bomb) was similar in construction to the NC 50 WC. It was filled with a composition giving off a white smoke and was fitted with fuze (AZ 46). The over-all weight was about 22 kg.

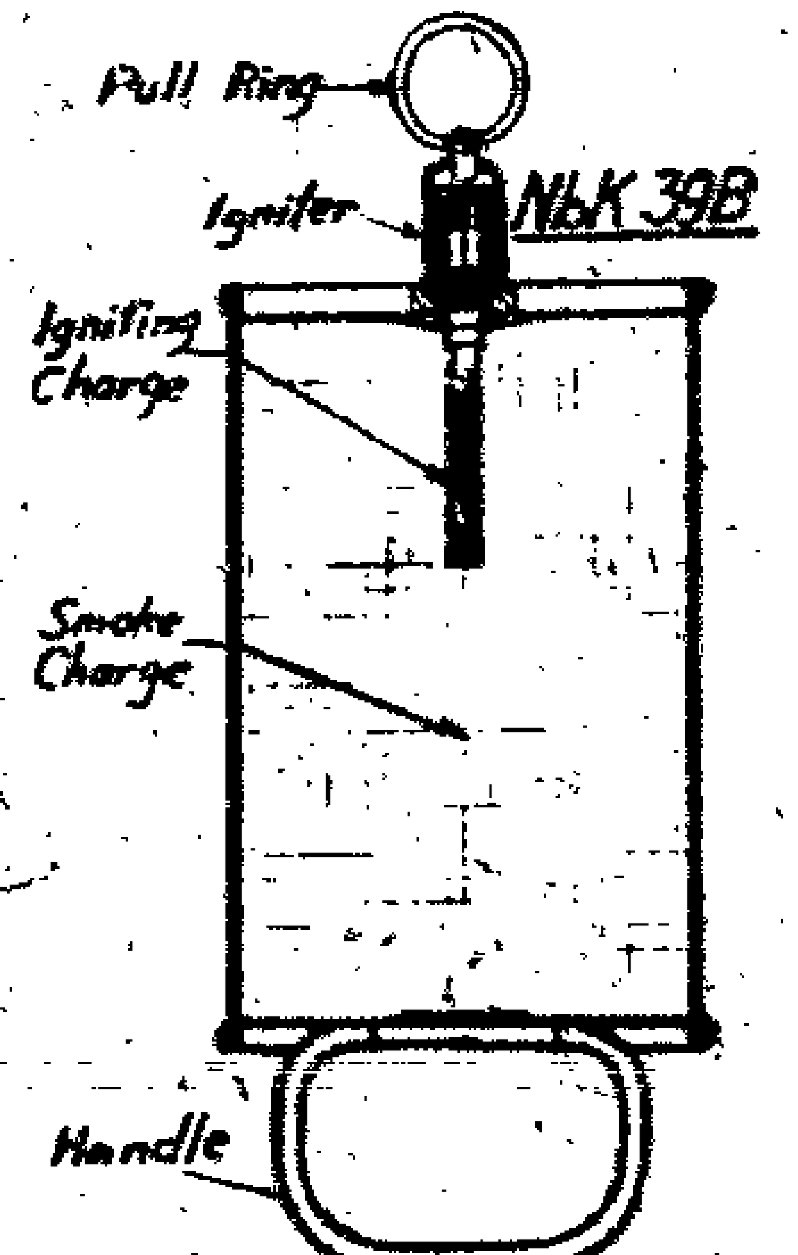
d) **NC 250 S** (Smoke Cylindrical 250 kg) consisted of a steel body (made of two longitudinal halves crimped and welded together) and four tail fins. Inside the body was located the central tube which contained a burster charge (TNT), a wooden block and an impact fuze. The smoke composition (mixture of chlorosulfonic acid 40 and sulfur trioxide 60%) filled the space between the walls of the body and the central tube. The detonation of the burster charge caused scattering of the surrounding acid mixture which, on contact with the air, emitted an intense white smoke.



Smoke Candle (Nebelkerze, Rauchkerze) is a cylindrical container with a compressed pellet emitting on burning a dense smoke. The following smoke candles are briefly described in CIOS Rept 32-13 (1945), pp 10-12 & 16-17:

a) Smoke Candle (NbK 39B), also described by F.G. Haverdack, Pic Arsn Tec Rept 1440 (1944) consisted of a sheet metal cylinder, 140 mm long and 91 mm diameter. Its bottom cover was solid and provided with a handle, whereas the top cover which had 7 perforations held the igniter assembly. Inside the cylinder was a pressed pellet of the smoke composition weighing about 1.8 kg. This composition, according to CIOS Rept 32-13, consisted of Hexa (hexachloroethane) 59-60, Zn dust 39-40 and Ba nitrate 1-2 and, according to Pic Arsn Tech Rept 1440, of Hexa 48, Zn powder 50 and binder 2%. Total weight of the device was 4 lb 2½ oz.

For operating the NbK 39B, the split ring of the igniter was pulled. The friction wire, being pulled through 0.035 g of composition containing antimony sulfide 54, K chlorate 33 and mercury fulminate 13% caused it to ignite the igniter. This consisted of an upper layer, 0.315 g of mixture: Pb_3O_4 (red lead) 75.4, silicon 18.0 and fuel & binder 6.6% and a lower layer, 1.82 g of Pb chromate 50.0, K perchlorate 23.5, silicon



25.5 and binder 1.0%. After burning for about 5 seconds, the smoke charge was ignited. The smoke and gases generated on burning forced an exit through the zinc top liner beneath the two holes in the steel top. A large volume of dense grey smoke was emitted, according to CIOS 32-13, for about 3 minutes or for 4-7 min, according to PATR 1440

b) Fast Smoke Candle (NbK S 39B) was similar in construction to the NbK 39B with the exception of the filling and the method of use. Its smoke mixture consisted of Hexa 47.5, Zn dust 47.5 and Ba nitrate 5.0%, compressed in the form of a cylinder weighing 1.7 kg and having a burning time of 100-200 sec. It was operated by firing from a projector attached to a vehicle

c) Slow Smoke Candle (NbK L 42B) consisted of a round, sheet metal container about 480 mm long and 160 mm diameter, with three compressed increments of smoke composition (Hexa 65, Zn dust coarse 25, Zn dust fine 10, and Ba nitrate added 0.75 - 1.5%) weighing 17.5 kg. It was ignited by means of a 300 g layer containing: Hexa 47.5, Zn dust 47.5 and Ba nitrate 5%. The emission time was 25-35 minutes

d) Black Smoke Candle (NbK L 42Sz) was identical in structure with the previous candle but contained a different smoke composition: Hexa 28, K chlorate 38, crude anthracene 33 and Kieselguhr 1%. It was pressed in three increments, total weight 12-13 kg. Ignition was effected by means either of a safety fuse igniter or a low tension electric igniter and a gaine. The time of emission was 10-16 minutes

e) Smoke Candle (NbK SSR 44) which served as a fixed aircraft smoke marker, consisted of a sheet metal cylinder, 140 mm long and 91 mm diameter provided with six 20 mm diameter emission holes and filled with a compressed mixture of Hexa 52.5, Zn dust 38.0, ZnO 4.0 and Mg powder 5.5%. Ignition was effected by a howitzer fuze and a gaine. The time of emission was 45-75 seconds

f) Black Smoke Candle (NbK S) which served as a fixed aircraft smoke marker, consisted of a sheet metal cylinder, 140 mm long and 91 mm diam, provided with four 15 mm diameter emission holes and containing two compressed pellets (total weight 1.2 kg) of the smoke composition: Hexa 25, K chlorate 45 and crude anthracene 30%. Same ignition assembly as above. Time of emission about 2 minutes

g) Black Smoke Candle (NbK Sz) constructed from a pasteboard 3 mm thick, was of the same dimensions as the above sheet metal container. The filling consisted of two compressed increments (total weight 1 kg) of Hexa 56, crude anthracene 30 and Mg powder 14%. Time of emission about 1 minute

h) Smoke Candle (SBrK II) which served to simulate the burning of vehicles, consisted of a pasteboard cylinder, 56 mm diameter and 280 mm high, filled with two hand pressed increments (total weight 600 g) of mixture: Hexa 28, K chlorate 40 and crude anthracene 32%. Time of emission of black smoke about 3 minutes

i) Smoke Candle (Tube) (NbK 45) which served as a flight indicator, consisted of a sheet metal tube about 700 mm long and 80 mm diam. The smoke mixture consisting of Hexa 48, Zn dust 47 and Ba nitrate 5 and weighing 12 kg, was pressed in directly. Ignition was effected by a howitzer fuze and a gaine. The time of emission was about 10 min.

Smoke Composition (Rauchsatz). Smoke compositions may be subdivided into two types:

a) Compositions which on heating developed a dense white or black smoke serving for screening purposes (Nebelstoff)

b) Compositions which on heating developed a colored smoke (Buntrauch), serving for signalling purposes.

Many of these compositions are described under signal device, smoke bomb, smoke candle, smoke generator, smoke projectile, smoke signal and under pyrotechnics.

According to CIOS Rept 32-13 (1945), p. 18, several smoke compositions were being developed towards the end of the WW II but were never put into service. Several compositions were prepared by adding to the mixture of Hexa (hexachloroethane) and Fe powder varying amounts of Mg, to accelerate the reaction. One such mixture contained Hexa 63, Fe 35 and Mg 2%. Very effective mixtures giving yellow to orange smokes were obtained by varying the proportion of the composition Hexa 48, Fe_2O_3 36 and Mg powder 16. A new mixture designed for smoke candles consisted of Hexa 50, Zn dust 40 and ZnO 10%.

Among other smoke compositions may be mentioned titanium tetrachloride, designated as FM (used in some smoke hand grenades), a mixture of oleum 80 and pumice 20% (used in some projectiles) and a black smoke mixture Mg 18.5, hexachloroethane 61.5, naphthalene 12.0 and anthracene 8.0% (used the Black Smoke Cartridge).

References:

1) E.W.Bateman, CIOS Rept 32-13 (1945), pp 10-18
2) H.J.Eppig, CIOS Rept 32-56 (1945), pp 3-5 & 17-18
3) Anon, TM 9-1985-2 (1953), pp 89, 325, 327-8 & 329
4) Anon, TM 9-1985-3 (1953), pp 402, 473, 497 & 506.
(See also References under Colored Smoke).

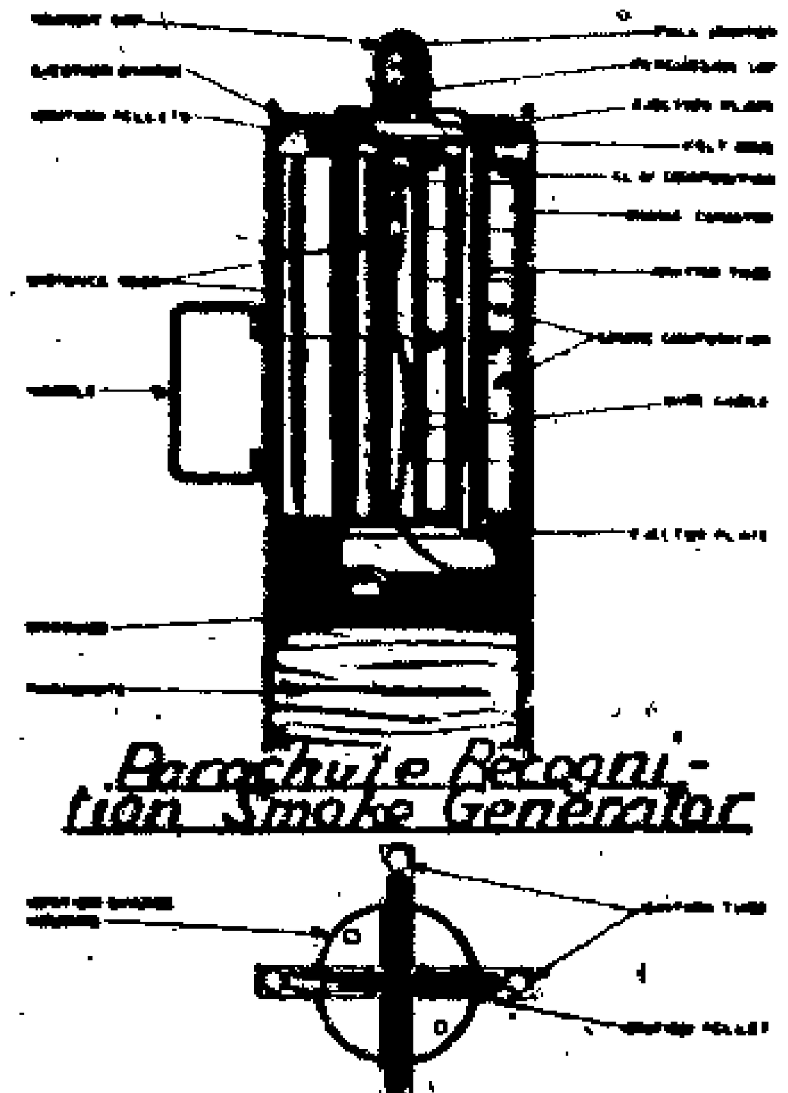
Smokeless Propellant or Smokeless Powder (Rauchlose Pulver oder Rauchschwaches Pulver). See Propellant.

Smoke Flare. See under Flare,

Smoke Generator (Raucheutwickler). According to E.W.Bateman, CIOS Rept 32-13 (1945), p 10, all German generators examined by him consisted of a sheet metal container (with one or several emission holes) filled with one of the varieties of Berger mixtures. In these mixtures the hexachloroethane (abbreviated as Hexa) was used as the source of chlorine and this reacted with metals such as Zn or Fe. The latter metal was used when smoke of an orange-yellow color was desired. All smoke compositions were ignited by means of an igniter assembly.

Several smoke generators are described in this (German) section under Smoke Candles. They are called in German Nebelkerzen.

One of the generators, namely, Parachute Recognition Smoke Generator is described in TM 9-1985-2 (1953), pp 89-92. The device consisted of an aluminum cylinder divided into two sections, one housing the smoke producing parts and the other the parachute. The first section was subdivided into subsections by three metal plates which were connected by twelve metal distance rods. Eight of these rods were equally spaced around the circumference of the plates while the remaining four were spaced an equal distance from and closer to the center. The smoke canisters



were firmly held in two tiers, each with four canisters. Four 1.4 in holes were drilled in the plates for the igniting tubes. The individual smoke canisters were aluminum cylinders lined with stiff waterproof paper and containing four annular blocks, three of smoke composition and one of a clay-like substance. The smoke composition consisted of a heat stable blue dye 42 mixed with K chlorate 33 and lactose 25%. Each of the three smoke composition blanks had a small quantity of priming composition (black powder) placed in the loose condition at the base before pressing to ensure ignition between one block and the next. The ignition pellets were arranged to accept the flash from the ejection charge and distribute it to the four ignition tubes, each of which pierced the center of two smoke canisters. A total of fourteen black powder ignition pellets were packed in these tubes. The ejection charge, positioned directly below the pull igniter, consisted of ½ oz of fine mesh black powder. Below this was the first metal ejector plate which had a hole in the center to allow the flash to reach the ignition pellets. The second ejector plate, designed to prevent the parachute from becoming damaged or entangled in the outer container, was placed in the lower part of the upper container directly above the parachute. The parachute canopy was made of continuous filament viscose rayon. Total weight of the generator was 27.5 lb, overall length 20" and maximum diameter 8"

For operating the device, the transit cap was removed, the friction igniter cap was unscrewed and pulled longitudinally, and the ensemble allowed to fall clear. After a delay of 4 to 5 seconds, the igniter functioned and the flash from the detonator passed to the ejector charge, to explode it. The pressure of the gases of explosion forced out the upper (smoke) section of the cylinder which, in turn, pulled out the parachute. At the same time, the flash from ejector charge ignited the pellets of black powder which distributed the flame to the four ignition tubes, each of which pierced the center of a smoke canister, thus igniting the smoke composition. Each canister emitted smoke of good density for about 26 seconds.

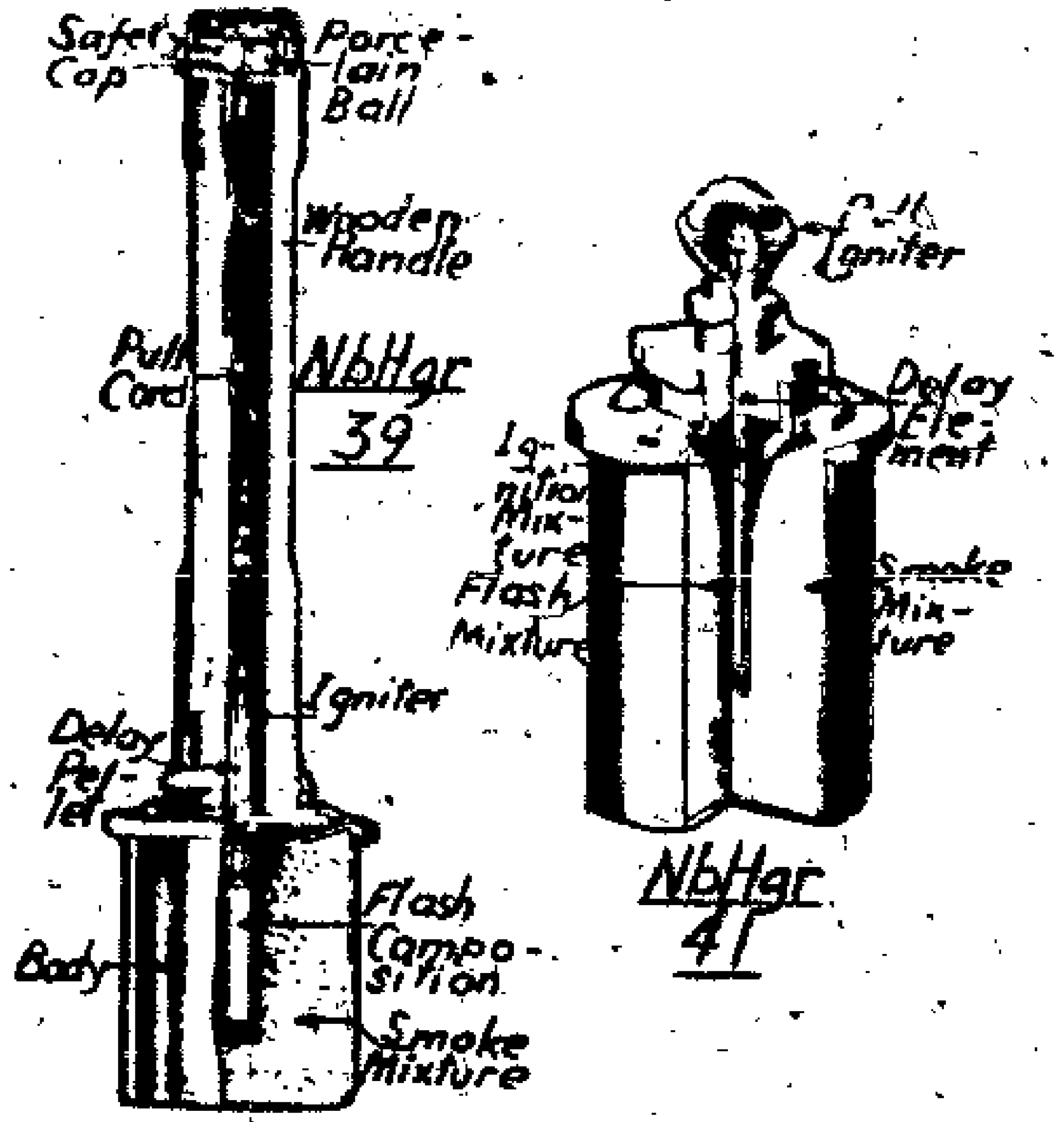
Smoke Grenade. See Smoke Hand Grenade and under Pistol Grenade and Rifle Grenade.

Smoke Hand Grenade (Nebelhandgranate oder Blendkörper). The following types are described in TM 9-1985-2 (1953), pp 325-330:

a) Smoke Hand Grenade 39 (NbHgr 39) closely resembled the HE stick grenade 24 in external form and size. It was filled with a smoke mixture containing hexachloroethane and Zn dust. Total weight 1 lb 14 oz and overall length 14". Duration of smoke 2 minutes. Was used for screening machine gun nests and pill boxes (pp 326-7)

b) Smoke Hand Grenade 41 (NbHgr 41) was similar in construction to the NbHgr 39, except that it was not provided with the stick (handle). Maximum diameter 2.4", overall length 4.7" and total weight 21 oz. Was filled with hexachloroethane - Zn dust mixture. Same time of emission and used as in the NbHgr 39 (pp 325-6).

Note: According to CIOS Rept 32-13 (1945), p 13, the composition of the smoke mixture was: Hexa (hexachloroethane) 55.0, Zn dust 43.5, and Ba nitrate 1.5%. The weight of the charge 400 g and the time of emission 150-250 seconds.

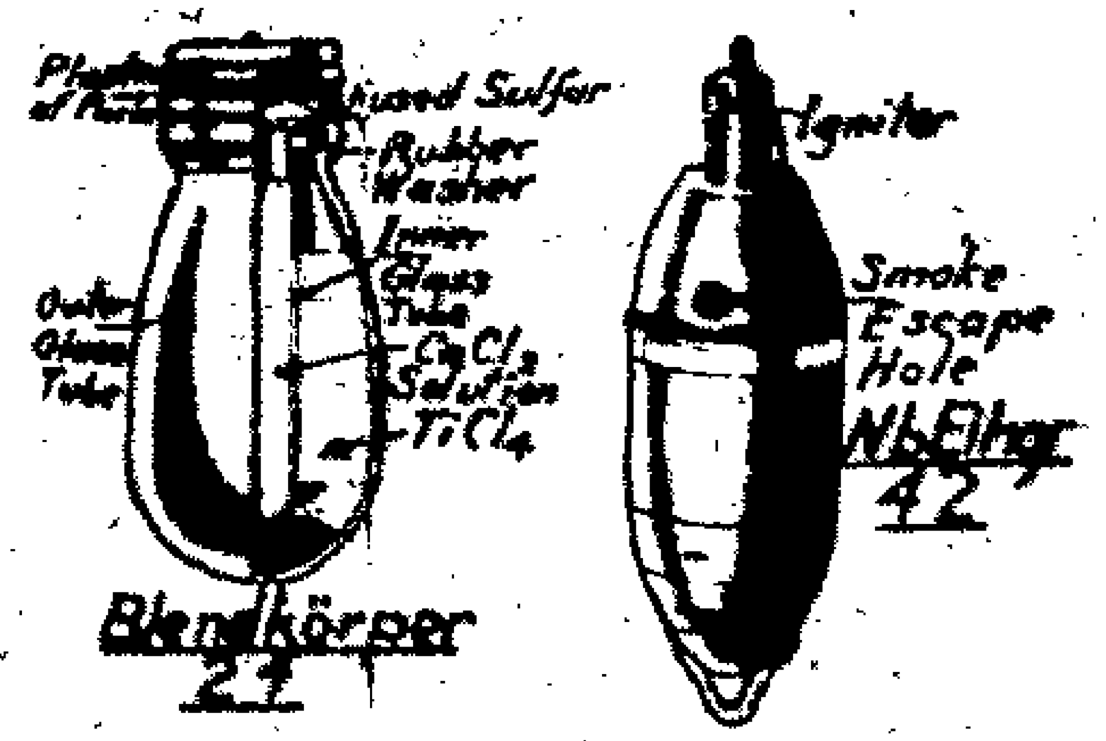


c) Smoke Hand Grenade (Blendkörper 14) consisted of a tear drop shaped glass flask (2½" diameter), provided with a cardboard handle and filled with 10.6 oz of titanium tetrachloride (FM). Its overall length was 6" and total weight 13.2 oz. The grenade was used to produce a small smoke screen to blind the enemy or to patch gaps in larger smoke screens. The flask could be easily broken by throwing it against a hard surface. On vaporization the tetrachloride formed a dense smoke, if the relative humidity was high (pp 327-8)

d) Smoke Hand Grenade (Blendkörper 2H) consisted of an outer glass bulb of molded construction containing 270 g of titanium tetrachloride and an inner glass tube containing 36 g of an aqueous solution of Ca chloride which was seated on a rubber washer in the neck of the outer container. The ensemble was sealed by a sulfur and cement plug. The contents of the inner tube served to provide the water necessary for the reaction with tetrachloride in the formation of heavy smoke. The Ca chloride was probably added as an antifreeze. The grenade was operated in the same manner and for the same purposes as the Blendkörper 14. (p 328)

e) Egg Type Smoke Grenade (NbEihgr 42) consisted of a cylindro-ellipsoidal shaped metallic container, 4.3" long and 1.7" diameter filled with a smoke composition. One end of the body was flattened to permit the insertion of the pull type igniter ZdSchnAnz 29 (p 329).

Note: According to CIOS Rept 32-13 (1945), p 13, the composition of the smoke mixture in the NbEihgr 42 was: Hexa (hexachloroethane) 55.0, Zn dust 43.5 and Ba nitrate



1, %. The weight of the mixture was 170 g and the time of emission 60-100 seconds.

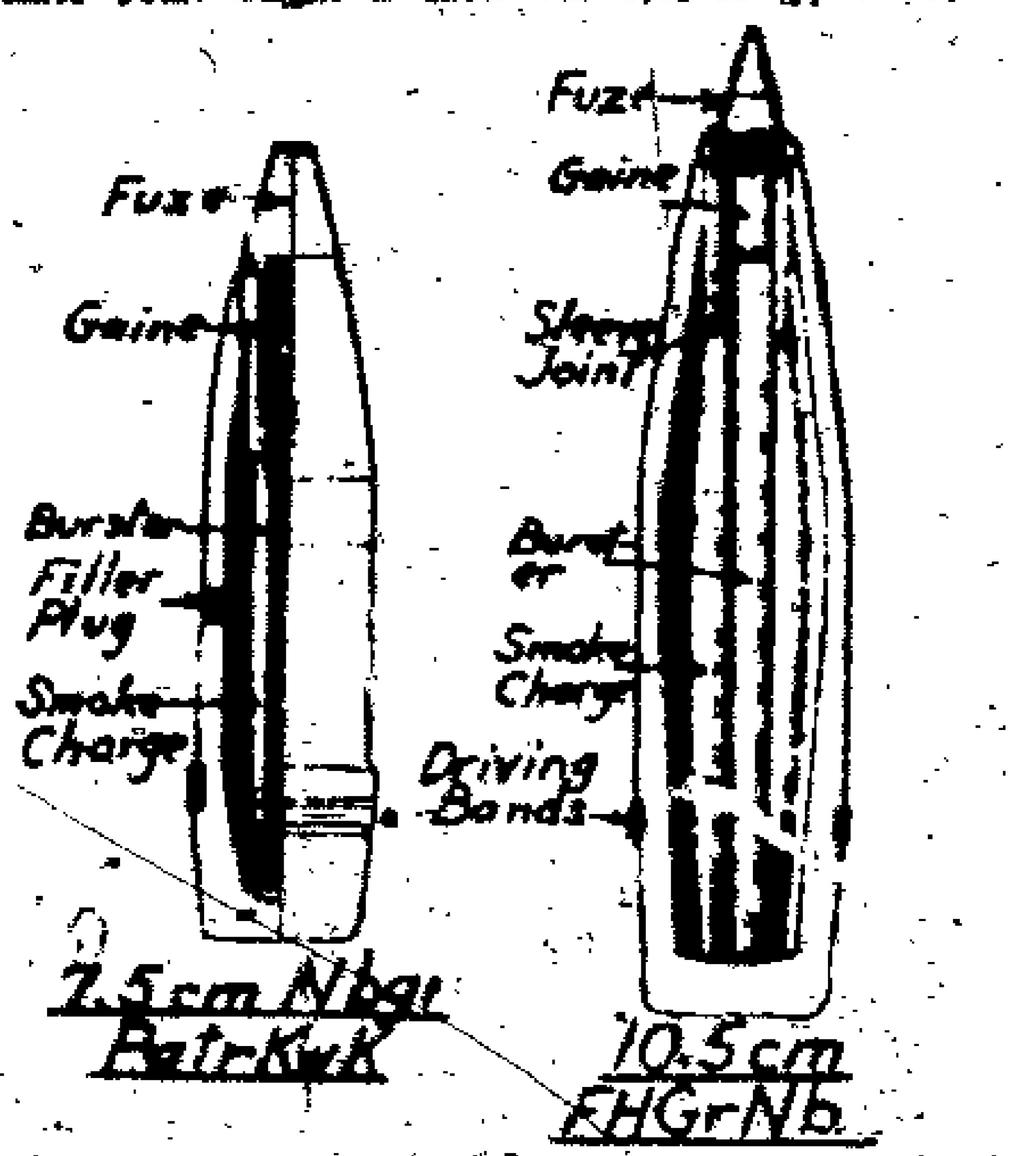
Smoke Hand Signal. See under Signal, Device and also under Pyrotechnics.

Smoke Pistol Grenade. See under Pistol Grenade.

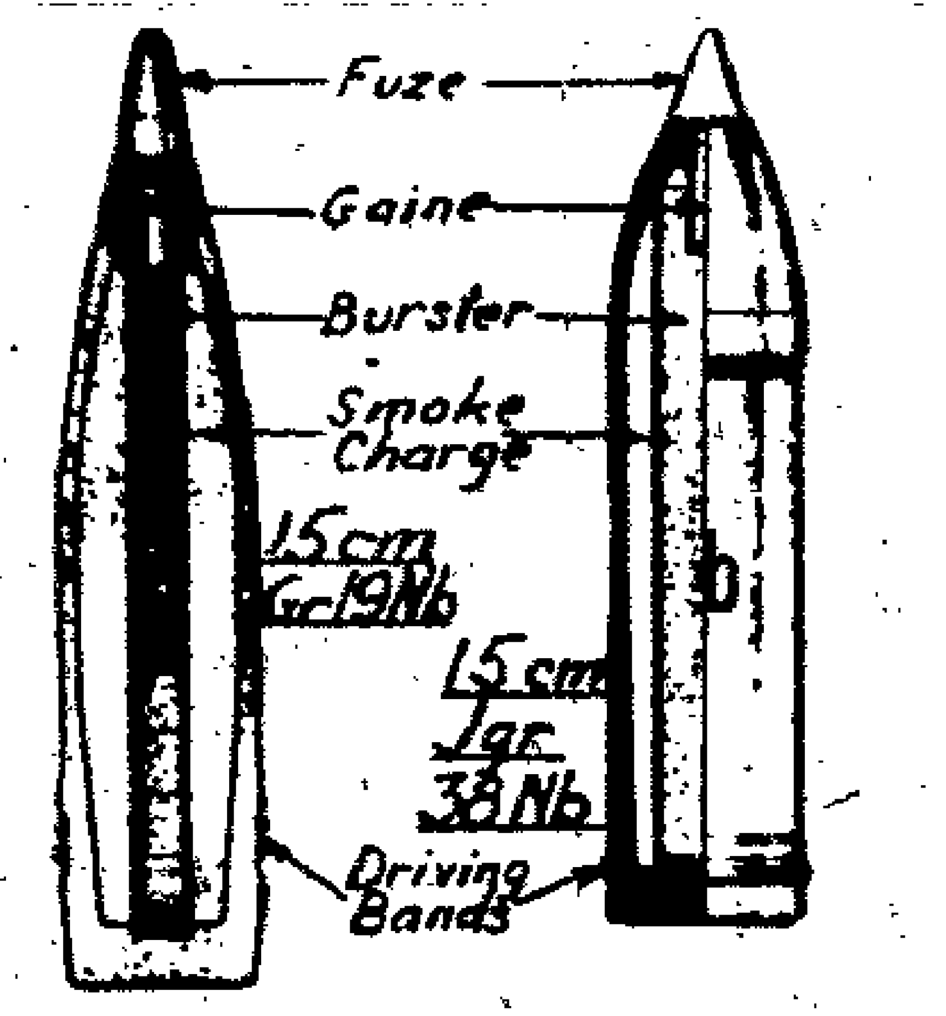
Smoke Projectile or Shell (Nebelgeschoss, Rauchgranate). Projectile containing a large charge of smoke producing composition and a small charge of bursting explosive. Several types of such shells were used during WW II by the Germans. These shells, on explosion, produced some fragments which were effective against personnel (but not against objects) and a dense smoke or fog which served to prevent the enemy from seeing what was going on. In some cases the smoke projectiles were used for spotting purposes, as for instance the 80 mm Colored Smoke Mortar Projectile.

The following smoke projectiles are described in TM 9-1985-3 (1953), pp 402-3, 472-3, 496-8, 506-7, 512 and 531-2:

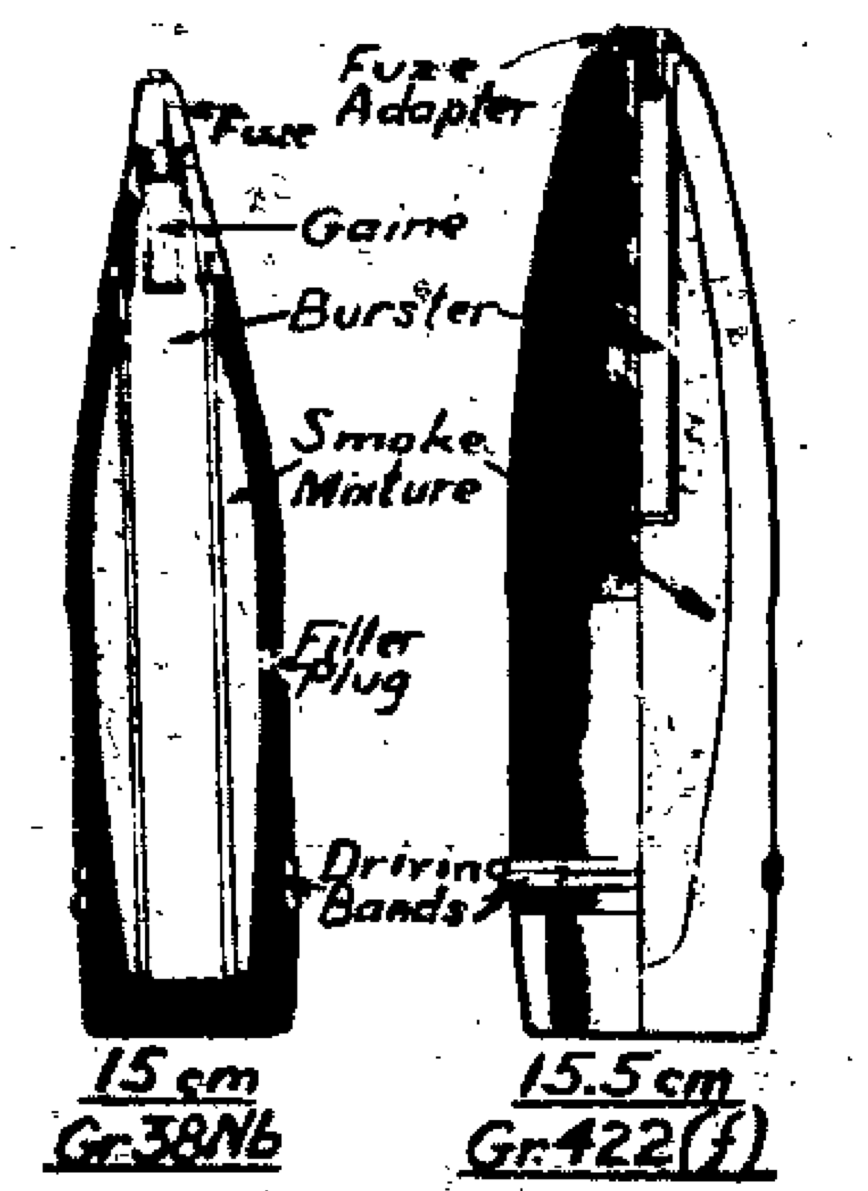
a) 75 mm Smoke Projectile for the Tank Gun (7.5 cm NbgrPatr KwK) was machined to the same design as the HE projectile. The inner tube contained a small burster charge (2 oz of picric acid) and a large charge of oleum, 80 parts, impregnated in 20 p of pumice stone. Total weight of shell was 13.6 lb (pp 402-3)



b) 105 mm Smoke Projectile for the Field Howitzer (10.5 cm FHGrNb) was similar in construction to the previous shell. It contained 4.3 oz of P A (bursting charge) and 4.1 lb of smoke charge (oleum impregnated in pumice). Total weight of projectile 30.8 lb (pp 472-3)
c) 150 mm Smoke Projectile, Type 19 (15 cm Gr 19Nb) for the Heavy Howitzer 15 cm sFH 13 or sFH 18, was similar in construction to the previous shell. It contained 1.21 lb of P A (bursting charge) and 14.08 lb of oleum impregnated in pumice. Total weight of projectile 85.8 lb (pp 496-8)
d) 150 cm Smoke Projectile (15 cm Jgr 38Nb) for the Heavy Infantry Gun 15 cm sIG 33 had a larger inner burster tube than the previous type. It contained 4.93 lb of P A (in the burster tube) and a smaller charge of smoke mixture (oleum/pumice) than the 15 cm Gr 19Nb. Total weight 80.4 lb (pp 506-7)
e) 150 mm Smoke Shell, Type 38 (15 cm Gr 38Nb), for the Heavy Field Howitzer (15 cm sFH 18) was similar in construction to the 15 cm Jgr 38Nb, except that its bursting charge consisted of TNT. Total weight not given (pp 506-7)



f) 155 mm Smoke Projectile [15.5 cm Gr 422 (f)] for the French Heavy Gun 15.5 cm K 420 (f) LMle 1916 St Ch was of conventional design. Its inner (burster) tube was shorter than in the German designed smoke projectiles and extended to less than the half of the length of the shell (p 512)
g) 80 mm Smoke Mortar Projectile (8 cm Wgr 34Nb) for the medium (mittlerer) mortar (8 cm sGrW 34) and for the short (kurzer) mortar (8 cm kzGrW 42) was conventional in design. It carried a sulfur trioxide smoke mixture and a PETN/wax bursting charge. It weighed 7.85 lb and was provided with 12 fins (p 532)
h) 80 mm Colored Smoke Mortar Projectile (8 cm Wgr 38Deut) for heavy (schwerer) mortar (8 cm sGrWerfer 34) was of conventional design and carried 12 fins. It was loaded with a composition which gave a colored smoke on bursting (p 531)
i) 380 mm Smoke Mortar Projectile (38 cm Wgr 40Nb) for the heavy spigot mortar (38 cm schweres Ladungswerfer) was of the same design as the corresponding HE mortar projectile described on p 535 of TM 9-1985-3 (1953)
j) 353 mm Anticoncrete Projectile (35.3 cm GrBek for the Howitzer (35.3 cm Haubitze M1) is briefly described under Spotting Projectile
k) 105 mm Field Howitzer Smoke Shell (10.5 cm FHGr 40Nb) [briefly described on p 14 of CIOS Rept 32-13, (1945)] was filled with 1.8 kg of the smoke mixture



containing: hexachloroethane 55, Zn dust 43.5 and Ba nitrate 1.5%. The time of emission was 4-7 minutes.
Note: According to H.H.Bullock of Picatinny Arsenal, all German smoke and chemical projectiles were loaded from the side. This was contrary to the American practice of loading projectiles through the throat.

Smoke Puff Cartridge. According to H.J.Eppig, CIOS Rept 32-56 (1945), p 6, such an item was developed by the Deutsche Pyrotechnische Fabrik at Kieselbach/Vecha, but the item is not described.

Smoke Rifle Grenade. See under Rifle Grenade.

Smoke Rocket. See Smoke and Chemical Rocket.

Smoke Shell. See Smoke Projectile.

Smoke Signal Device. See under Signal Device.

Smoke Signal, Hand. See under Signal Device and under pyrotechnics.

Smoke Stick (Nebelstab), which served as a wind direction indicator, consisted of a sheet metal tube, about 100 mm long and 16 mm diameter, attached to a wooden handle about 50 mm long. Its smoke filler consisted of six pellets containing: lactose, K chlorate and Am chloride (exact composition is unknown). It was ignited by means of a cap with a friction surface.
Reference: E.W.Bateman, CIOS Rept 32-13 (1945), p 18.

Smoke Tube (Rauchrohr), was a smoke emitting device consisting of a seamless drawn tube, 250 mm long and 25 mm diameter, into which the following compositions were pressed by hand:
a) Main layer: hexachloroethane 49, Zn dust 41, Zn oxide 4 and Mg 6% and
b) Initiating layer: hexachloroethane 55, Zn dust 41 and Mg 4%. Ignited by a safety fuse.
Total weight of the device was about 200 g and time of emission not less than 60 sec.
Reference: CIOS Rept 32-13 (1945), pp 13-14.

Snap Type Igniter (Knickzünder). See under Igniter.

Snorkel oder Snort. See Schnorchel.

Sodatol. An explosive containing Na nitrate 55 and TNT 45%. It was suitable for loading bombs and shrapnel shells. [A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), p 277].

Sodium Azide (Na A) (Natriumazid). See general section under Azides. Na A was used in Germany for the manufacture of lead azide (L A), as described in PB Rept 95,613 (1947), Section 0 (See also under Bleiazid).

Sodium Chloride Explosives or Kitchen Salt Explosives (Kochsalzsprengstoffe). German substitute explosives containing large amounts of NaCl (up to 60%). They are described under Ersatzsprengstoffe.

Sodium Nitrate Explosives (Natriumnitratsprengstoffe). Explosives containing Na nitrate, such as Sodatol and some explosives described under Ersatzsprengstoffe.

Sodium Picrate (Natrium Pikrat). See general section under Picrates. It was used during WW II in Germany as a component of GP (Powder), proposed as a substitute for black powder and as a propellant for Panzerfaust. In this composition the picrate was mixed with a binding substance such as Igetex SS.
Reference: CIOS Rept 25-18 (1945), pp 27-28.

Solid Catalyst. See MP-14.

Solvents and Plasticizers for nitrocellulose, plastics (such as polyvinyl chloride), resins, synthetic rubbers etc were described in some BIOS, CIOS and FIAT Reports, and especially in BIOS Repts 1651 and 1652. These two reports covered the investigation during November-December 1946 in the field of solvents and plasticizers sponsored by the Raw Materials Division of the (British) Board of Trade. The field of investigation did not include petroleum and chlorinated hydrocarbons. A brief description of the methods of preparation of about 150 solvents and plasticizers were given but no data for the solubility of NC, etc. Some properties of plastics are given in the above reports.

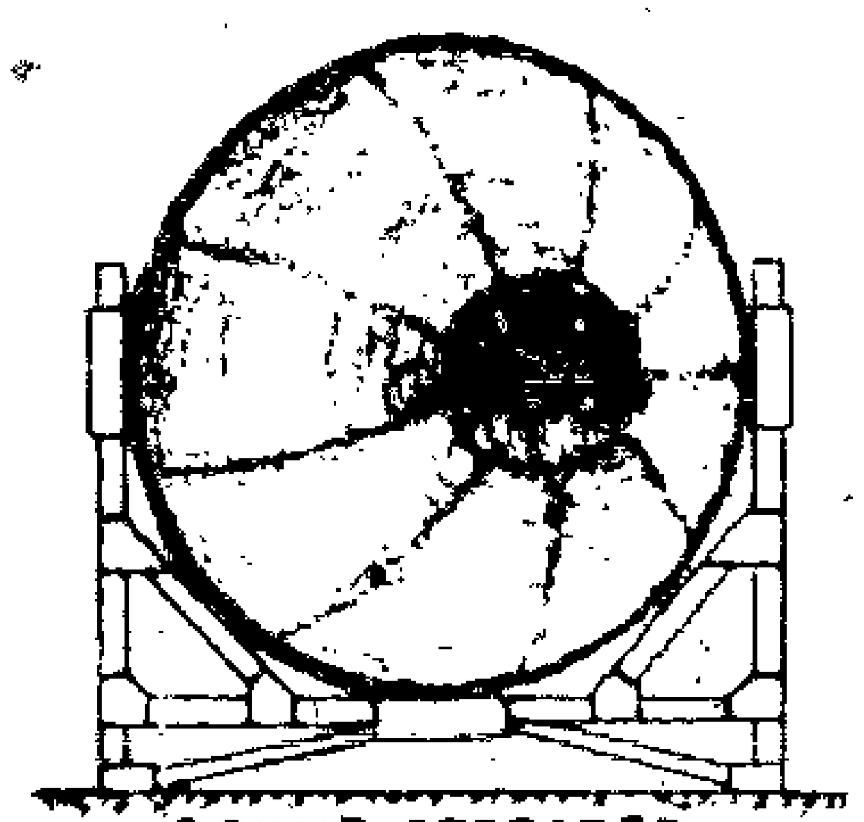
Soman. See under Trilons.

Sondertreibstoff (Special Propelling Material), developed during WW II by IG Farbenind, was presumably intended for use as jet propulsion fuel. It contained an unsaturated compound (diketene) which reacted with concentrated (90% +) nitric acid with explosive violence. The reaction time was within hundredths of a second.

The mixture finally developed contained: divinylacetylene (diketene) 5-6, vinyl acetate 6-12, benzine 70, diethylaniline 1 and iron carbonyl 10%.

Note: The composition does not add to 100%. The large amount of iron carbonyl appears questionable.
Reference: CIOS Report 25-18 (1945), pp 20-21.

Sound Gun. This weapon constructed by R.Wallauschreck of Austria, was designed to cause casualties or damage by means of sound waves of great intensity. It was claimed that at short range (say 60 m) it could kill a man and at greater ranges (say 300 m) it could disable him for an appreciable length of time. A brief description of this device is given by L.E.Simon, German Research in WW II, Wiley, NY (1947), pp 181-2. The weapon consisted of a parabolic reflector, 3.2 meters in diameter, having an attachment extending to the rear of the vertex of the parabola. The attachment consisted of a firing chamber (for producing energy for sound), the length of which was ¼ of the wave length of the sound. At its rear, the chamber was provided with two coaxial nozzles, the outer nozzle emitting methane and the inner one emitting oxygen. The frequency of sound was from 800 to 1500 impulses per second and the pressure produced by the sound waves was



SOUND OPERATED WEAPON

equal to 1000 microbars, when measured at a distance of 60 meters. The military value of this weapon was slight due to its short range.

"Sonne" Guidance System for Missiles. See under Guidance Systems for Missiles.

Space Explosions with Carbon Dust. See under Krümmel Fabrik Dynamit A-G Pressing of Explosives and Research and Development Work.

Spalt Fusehoads or Splitting Priming Drops. When shooting in coal mines where considerable uncontrolled electric currents are to be found, the fuseheads of electric blasting caps or detonators have to be constructed in such manner that they shall not ignite from a potential as high as 15 volts. This was achieved at the Troisdorf Fabrik, D A -G by using special tension fuseheads in the resistance range of 3000 to 50000 ohms.

For preparing such fuseheads the tip of the bridge wire was dipped successively into the following compositions, allowing the material to dry after each dip:

a) 1st dip composition, which consisted of Pb peroxide 43 g, cerium - magnesium alloy 28.5 g and Al (particle size 10 to 20 microns) 28.5 g suspended in about 70 ml of a 3% soln of NC in amyl or butyl acetate

b) 2nd dip composition consisted of red lead (particle size less than 5 microns) 90 g and silicon (particle size 20 to 40 microns) 10 g suspended in a 3% soln of NC in amyl or butyl acetate

c) 3rd dip composition was a lacquer consisting of a 15% soln of NC in 75/25-butyl acetate/ethanol, to which was added Sipalin AOM (methylcyclohexyl ester of adipic acid) in the amount of 20% of the dry weight of NC.

The storage stability of these fuseheads in moist atmosphere was not very good.

Note Soldering of the bridge (fuse) wire to the lead-in wires, preparation of dry ingredients for fusehead dips, preparation of NC lacquers and the process of dipping the fusehead combs are described under Fusehead Manufacture.

References:

1) B I O S Final Rept 833, Item 2 (1946), p A3/35

2) P B Rept 95,613 (1947) Section D.

Spezifische Energie oder Spezifischer Druck, designated as "f". See Specific Energy, or Specific Pressure in the general section.

Spezifisches Gewicht See Specific Gravity in the general section.

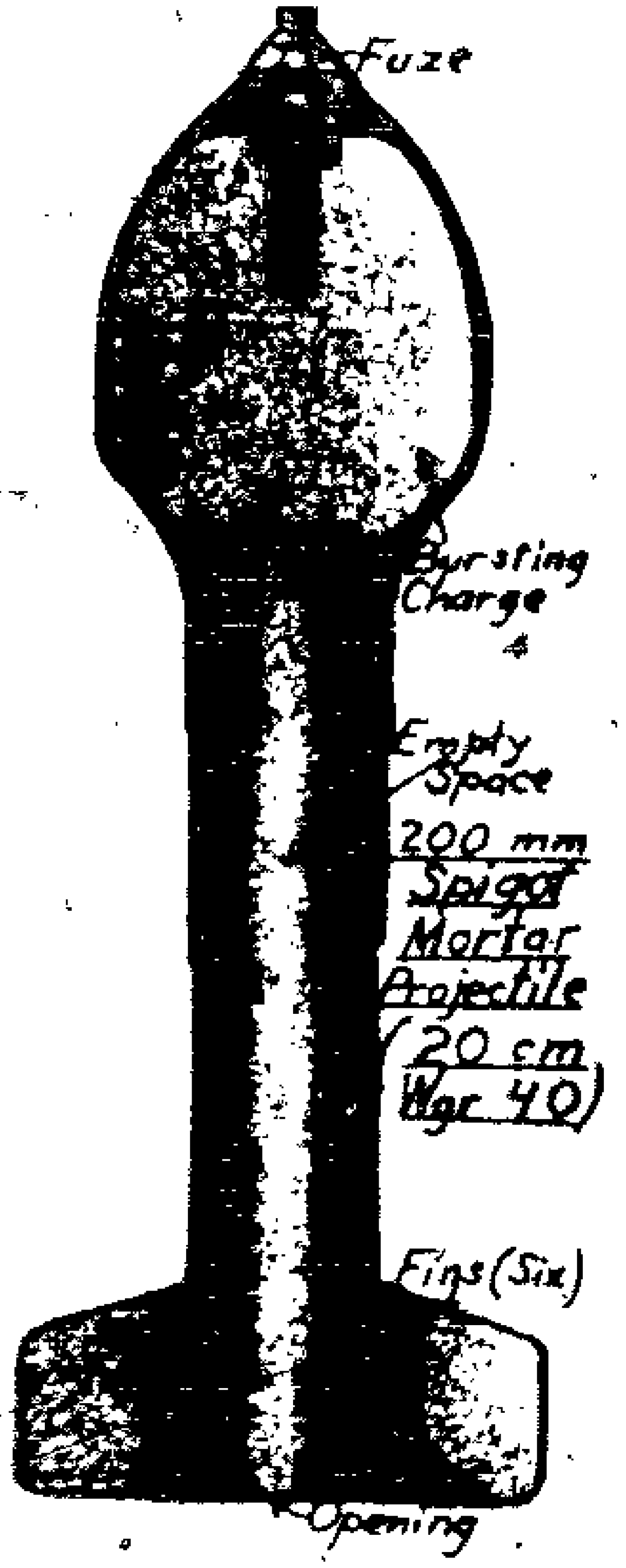
Spezifische Wärme. See Specific Heat in the general section.

Spigot Mortar (Ladungswerfer) Projectile. The following projectiles are briefly described in TM 9-1985-3 (1953), pp 534-5:

a) 200 mm Mortar Projectile, 20 cm Wgr 40 (Werfergranate 40) for use in the light (leichter) spigot mortar 20 cm lLadungswerfer) consisted of two sections, one housing about 17 lb of bursting charge (TNT) and the other propellant in three sections each weighing 12 g. Total weight of the round was about 50 lb (p 534)

b) 380 mm Mortar Projectile (38 cm Wgr 40) for the heavy spigot mortar (38 cm sLadungswerfer) was similar in design and shape to the 20 mm projectile. It contained 110 lb of HE bursting charge and was provided with 6 fins. Total weight of projectile was about 328 lb (p 535).

Note: There is no indication in the above manual how this projectile was fired and what kind of spigot mortar was used. It is probable, however, according to H.H.Bullock of Picatinny Arsenal, that the hollow tail section of the



projectile was placed (before firing) over a spigot which was in the form of a short tube. At the base of the tube was inserted a cartridge case with a propellant and a primer. The firing was probably done in a manner similar to that for the Sutton Mortar, i e by a striker held by a coiled spring and operated by a lanyard.

Spike Bomb. See Stachelbombe.

Spiralit (Spiralite)-A class of smokeless propellants prepared, in 1898, by nitrating sheets of paper and impregnating them with substances which slow down the rate of burning (moderants). The exact composition of these propellants was never revealed by the manufacturer, the Explosivstoff-Werke Spiralit Gesellschaft und Max Thorn, Hamburg. The charges were made by superposing and compressing several sheets of nitrated paper.

Reference: J.Daniel, Dictionnaire, Paris (1902), p 735.

Splitterdichte (Density of Fragments). See Fragments Density Test.

Splitting Process of Manufacture of Sulfuric Acid is briefly described under Sulfuric Acid Manufacture.

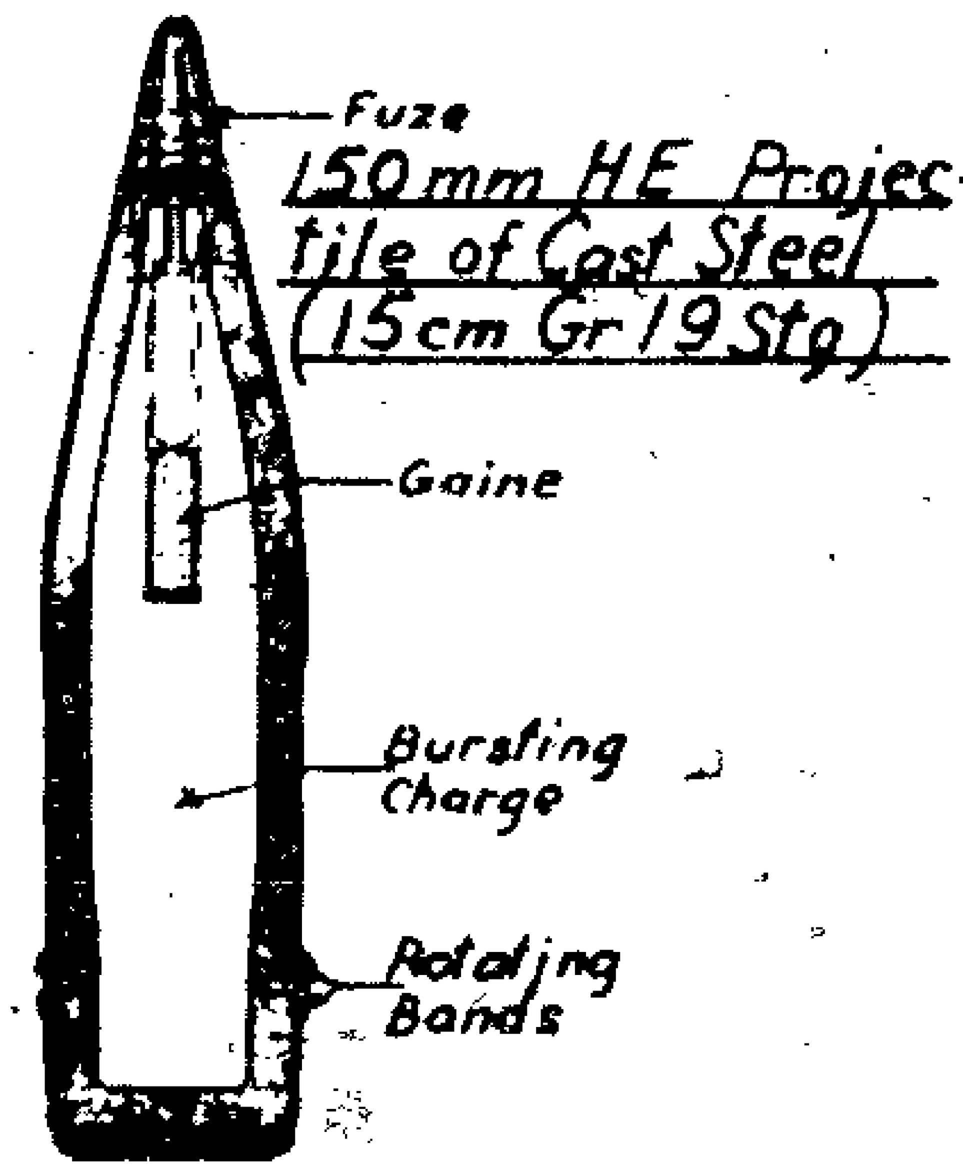
Sporting Powder. See Jagdpulver.

Spotting Projectile (Schussbeobachtungsgranate). A projectile serving for observation and adjustment of artillery fire. It contained a small charge of smoke composition in a separate container inserted in the high explosive charge.

The following projectiles are described on pp 405, 494-6, 500, 529 & 533 of TM 9-1985-3 (1953):

a) 75 mm HE Projectile (7.5 cm Igr 18 AZ 23nA) for the Light Infantry Gun (lIG 18) or Light Mountain Infantry Gun (lGIG 18). It was about 13" long and contained 1.21 lb of an Amatol. Directly under the gaine of the PETN booster (GrZdlg C/98 Np) was located a small charge of smoke composition (pp 405-6)

b) 150 mm HE Projectile 19 with Gaine 36 (15 cm Gr 19 mZdlg 36) for Heavy Field Howitzer 18 (sFH 18). It contained 11.22 lb of cast TNT as a bursting charge and a small smoke charge directly under the booster.



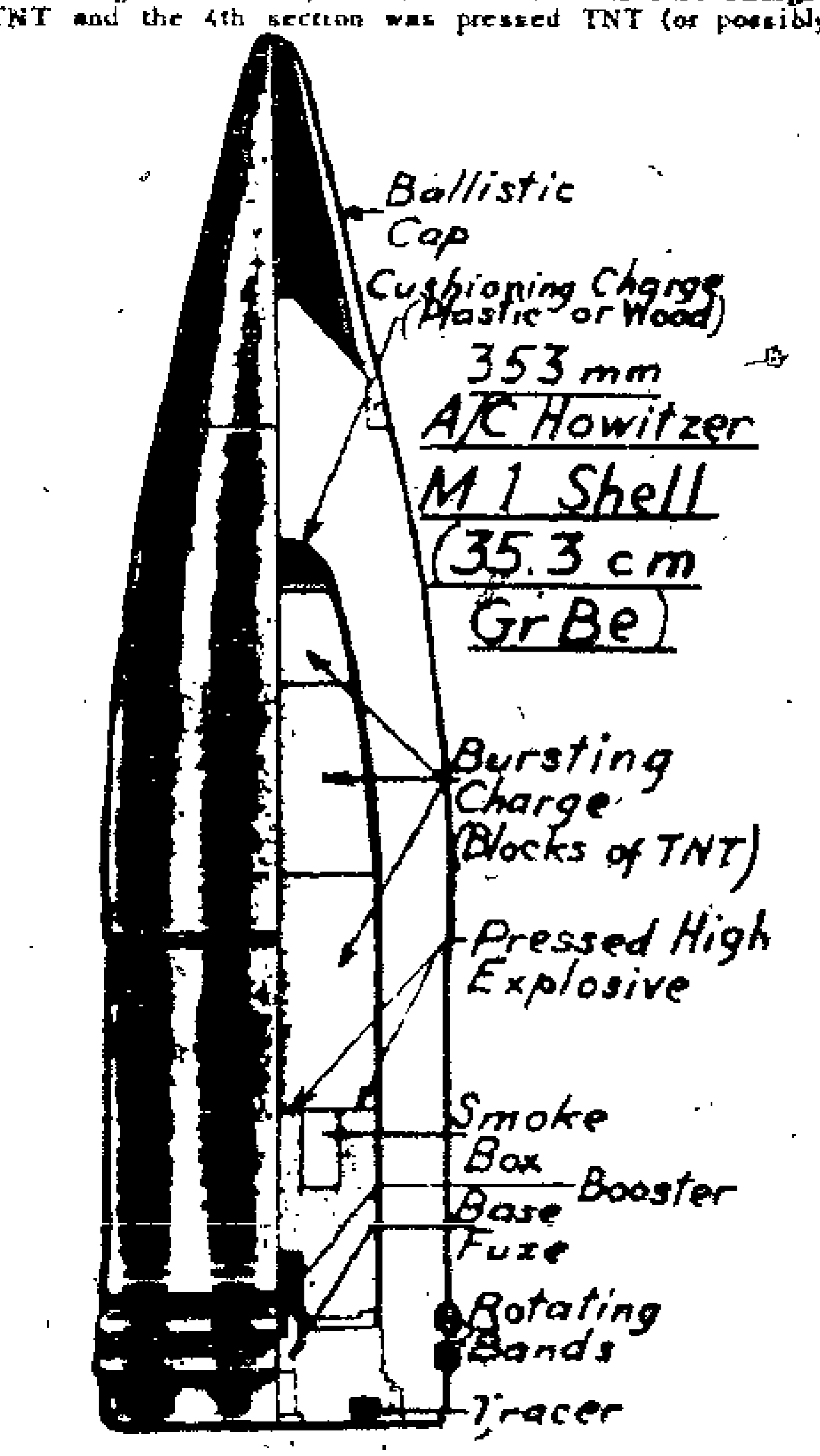
Total weight of projectile was 95.7 lb. Two types of point detonating fuzes were used: AZ 23 or DoppZ s/60. The base was provided with a screwed-in plate. (pp 494-5)

c) 150 mm HE Projectile of Cast Steel (15 cm Gr 19 Stg) for Heavy Field Howitzers (sFH 13 and sFH 18) and for Heavy Turret Howitzer (sHT). It was similar in appearance to the previous projectile, except that it did not have the screwed-in base plate. (pp 495-6)

d) 150 mm HE Projectile 19 (15 cm Gr 19) for Heavy Field Howitzers (sFH 13 and sFH 18) or for Heavy Turret Howitzer (sHT). It was about 25" long and contained 9.46 lb of TNT (in cardboard containers) as a bursting charge. A small charge of smoke composition was placed on the bottom of the shell. The projectile had a screwed-in base plate. Two types of point detonating fuzes were used: impact and combination (AZ 23 and DoppZ s(60)) and two types of boosters (GrZdlg C/98Np and GrZdlg C/98) (pp 500-501)

e) 353 mm Anticoncrete Projectile (35.3 cm GrBe) for Howitzer M1 was conventional in design and contained 75 lb of TNT as a bursting charge and a small charge of a smoke composition used for spotting purposes. Total weight of loaded projectile was 1265 lb.

Note: According to information supplied by H.H.Bullock and A.B.Schilling of Picatinny Arsenal, it might be assumed that the HE filling consisted of four sections loaded in a carton: the 1st and 2nd front sections were cast TNT containing 5-10% wax, the 3rd section was cast straight TNT and the 4th section was pressed TNT (or possibly

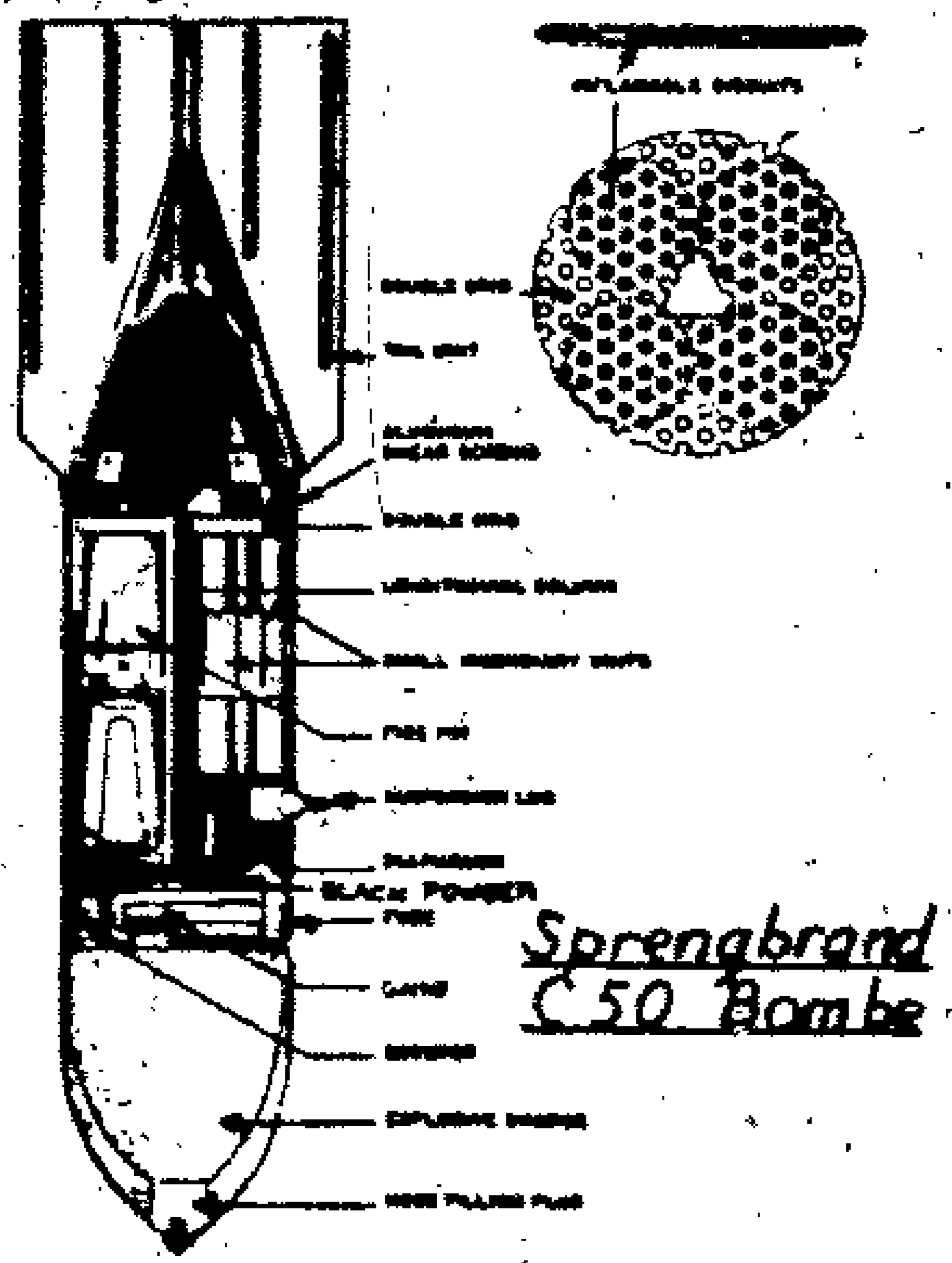


picric acid). It is presumed that the 4th section acted as an auxiliary booster, because it does not seem possible that the large mass of cast TNT could have been exploded by the small booster (shown on the drawing) which did not extend sufficiently into the bursting charge.

f) 100 mm Mortar Projectile (10 cm Wgr 37) used in 10 cm NbW 35. It contained 3.125 lb of TNT as the bursting charge and a small charge of smoke composition located underneath the booster (GrZdlg C/98Np) and the fuze (WgrZ 38). Total weight of the projectile was 16.0 lb (p 534).

Sprengbrandbombe (Combination Demolition – Incendiary Bomb). One such bomb, the **Sprengbrand C50 Bombe**, is described on pp 50-2 of TM 9-1985-2 (1953). The bomb was of the same shape as conventional HE bombs but its filling was different. The nose section of the bomb contained 20 lb of TNT and behind the charge was placed the fuze pocket. In the fuze pocket was located a bakelite gaine contg a black powder biscuit and a steel encased gaine contg a delay pellet and detonator; the whole assembly being held in place in the base of the fuze pocket by a leaf spring. A hole drilled through the rear side of the fuze pocket and through the diaphragm (which divided the bomb into two sections) led to a silk bag contg black powder. The powder served both as the igniting and expelling charge for the middle section of the bomb contg incendiaries. The incendiary units (six fire pots and 67 small triangular metal incendiary elements) were placed around a long triangular hollow steel column. Three double grids were placed in angular fashion around this column. Each pair of grids had four orange-colored biscuits of highly inflammable material pressed between them. These biscuits were ignited by the flash from the black powder expelling charge and, in turn, ignited the small incendiary units directly and the quickmatches of the six large units. The explosion of the black powder charge also sheared the aluminum screws securing the base plate and ejected the incendiary elements over a radius of about 100 yards. About 1 second after expulsion, the delay element in the booster reached the detonator and fired the TNT charge in the nose of the bomb.

Total weight of bomb was about 75 lb, overall length 42.5", body length 29.0", body diameter 8.0", wall thickness 0.15", tail length 16.0" and its width 11.3".



Sprengelsprengstoffe. See Sprengel Explosives in the general section.

Sprenggelatine (Blasting Gelatin). According to Stettbacher (Ref 1) the German Sprenggelatine contained: NG 91-93 and collodion cotton (N content 11.8 to 12.4%) 7 to 9%.

According to Weichelt (Ref 2) the 93/7 Sprenggelatine had the following properties: temp of explosion 4710 C, vol of gases at NTP 712 l/kg, density of loading 1.55, specific pressure (f) 1200 kg/cm^2, velocity of detonation 7800 m/sec, Trauzl test 520 cc and impact sensitivity with 2 kg. weight 12 cm.

References:

1) A.Stettbacher, Spreng- und Schiesstoffe, Zürich, (1948), p 82

2) F.Weichelt, Handbuch der gewerblichen Sprengtechnik, C.Marhold, Halle/Saale, (1955), p 374.

Sprengkapsel (Blasting Cap). See under Detonators.

Sprengkörper 02 (Spr Kpr 02) (Explosive Pattern 1902). A demolition charge weighing 200 g used during WW I for military pioneer work. It replaced a similar charge made of picric acid called Sprengkörper 88 [Colver High Explosives (1918), p 23].

Sprengkörper 28 (Spr Kpr 28). (Explosive Pattern 1928) consisted of TNT or P A in blocks 2"×1 3/8"×2 3/8" wrapped in wax paper or placed in bakelite containers. It was one of the demolition charges of WW II. It was used in some land mines, as for instance Glasmine 43(f).

References:

1) U S War Dept Tech Manual FM 5-25 (1945), pp 129-132

2) TM 9-1985-2 (1953), p 275.

Sprengmittel. An explosive in prepared form, as distinguished from the generic term Sprengstoff.

Sprengmunition 88 (Füllpulver 88 oder Fp 88) (Explosive Pattern 1888). The name given to picric acid (P A) adopted as a military explosive in 1888.

Sprengmunition 02 (Füllpulver 02 oder Fp 02) (Explosive Pattern 1902). The name given to TNT adopted as military explosive in 1902, replacing Sprengmunition 88.

Sprengniet (Explosive Rivet). See general section and also the paper of E.R. von Herz, Explosivstoffe, 1954, Heft 3/4, pp 29-38.

The Ger Pat 708,238 gives the following composition for use in explosive rivets: Al (powder) 65, mannitol hexanitrate 25 and tetracene 10%.

Sprengöl oder Nobel's Sprengöl. Same as Nitroglycerin.

Sprengpatrone 02 (Spr Ptr 02). Demolition charge weighing 1 kg used at the time of WW I for military demolition work. It replaced a similar charge, "Sprengpatrone 88", made of P A [Colver, High Explosives (1918), p 23].

Sprengriegel. See TM 9-1985-2 (1953), p 264 and also under Landminen.

Sprengsalpeter (Saltpeter Blasting Explosive). Any blasting explosive containing K and/or Na nitrate, charcoal/or

coal and sulfur, such as blasting black powder belongs to the class of Sprengsalpeter explosives.

Sprengstoff. Generic term for an explosive as distinguished from Sprengmittel.

Sprengzünder, Elektrische (Electric Blasting Cap, literally Electric Detonating Igniter). Two types of such devices are described by Beyling & Drekopf, Sprengstoffe und Zündmittel (1936), pp 222-6.

"S" Pulver (Spandau Powder). A propellant manufactured before WW I by treating the surface of single-base powder grains with an alcoholic solution of centralite or diphenylamine. This propellant was exported to Turkey.

Another kind of "S" Pulver was a sporting propellant prepared by nitrating sawdust and gelatinizing the resulting product.

Reference:

P.Pascal, Explosifs, etc, Paris (1930), pp 227-228.

Squeeze Bore Gun. See Note under Tapered Bore Gun.

SSP (Sicherheitssprengpulver). A safety explosive which is based on ammonium nitrate.

Reference: Daniel, Dictionnaire (1902), p 737.

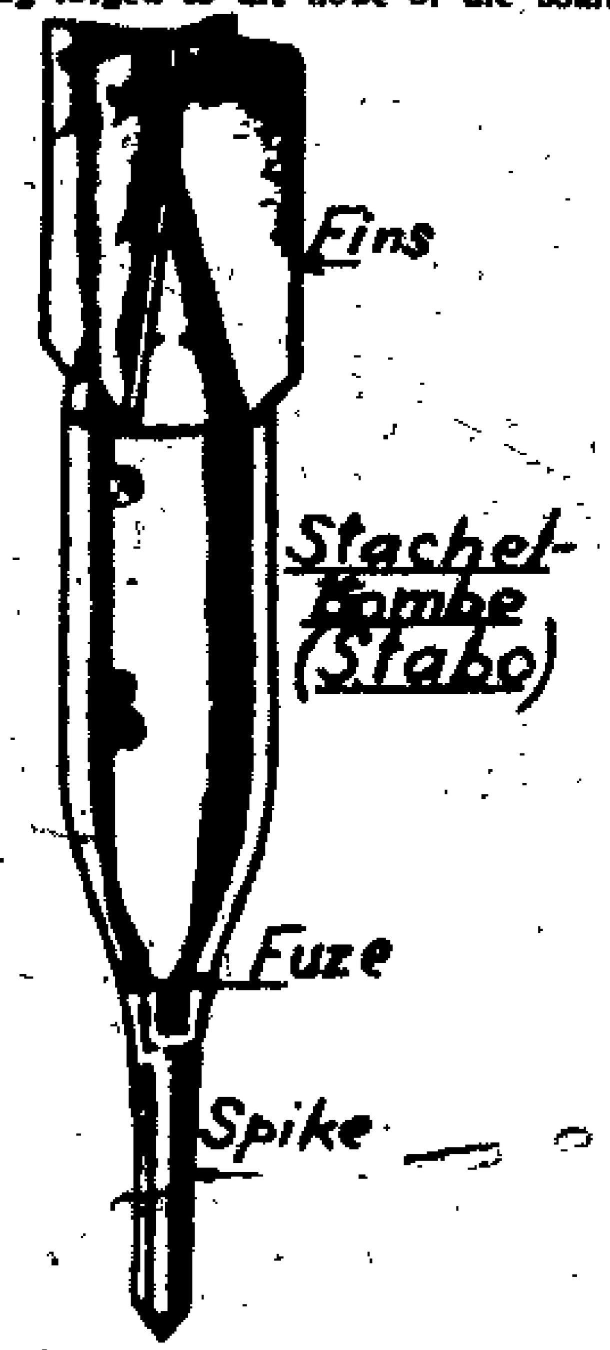
Stabilität oder Beständigkeit (Stability), **Lagerbeständigkeit** (Stability in Storage). Stability of explosives and the tests for stability are described in the general section.

Stabmine. See "B" Stabmine and also under Landminen.

Stabo. See Stachelbombe.

Stachelbombe, abbreviated as Stabo (Spike Bomb). Some German bombs, such as the SC 50, SD 70, SC 250 and SC 500 could be fitted with a spike by attaching it to a threaded lug forged to the nose of the bomb just above a fuze. The attachment was used in low altitude attacks to prevent the bomb from ricochetting.

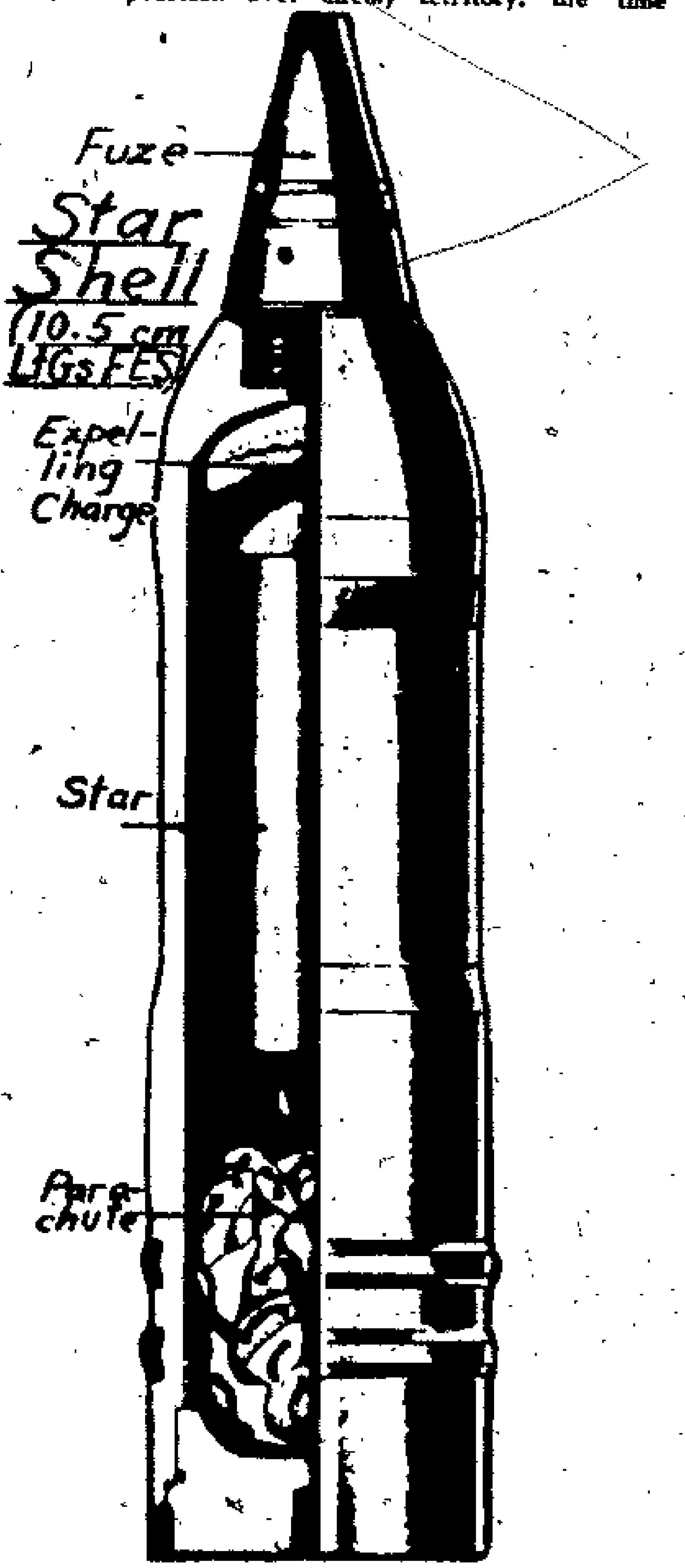
Reference: TM 9-1985-3 (1953), pp 21-2.



"Standard" Propellant (Einheitspulver or EP), called "Unit" Powder by H.H.M.Pike [CIOS Rept 31-68 (1945), p 6], was a "G" Pulver (diethyleneglycol dinitrate propellant) which contained 1.5% K nitrate or 3% hydrocellulose and had a calorific value of 710-730 kcal/kg. This mixture was introduced in 1944 as the "Service" propellant for all ammunition in order to minimize the differences in ballistics previously usually obtained when propellants with the same formula were manufactured at different plants. The incorporation of either K nitrate or of hydrocellulose was claimed to give much more uniform inter-plant ballistics of propellants.

Stanzprobe (Punch Test). See Analyt Section, Brisance Tests.

Star Shell. One of the projectiles (10.5 cm Leuchtgeschoss FES) described in TM 9-1985-3 (1953), p 464, contained a star unit attached to a parachute. When the shell reached a predetermined position over enemy territory, the time



fuse fired the expelling charge and the resulting pressure caused the star and the parachute to be ejected through the base of the shell. Simultaneously the flash from the burning gases of the expelling charge ignited the star composition. This shell served for illuminating the enemy's installations and troops in order to assist the artillery.

The shell weighed 31.3 lb and was fired from some captured 105 mm guns, such as Belgian, French, Polish and Yugoslav.

A larger projectile (203 mm) serving the same purpose but designated the Flare Projectile, is described on pp 519-20 of TM 9-1985-3. Its German designation was 20.3 cm Leuchtgranate and it was fired from the Railroad Gun, K(E). (See also under Flare).

Stauchprobe oder Brisanzprobe (Compression Test or Brisance Test, known also as Crusher Test). Two tests of this kind originated in Austria and Germany. The first method used the Deutscher Betriebs - Stauchungmesser, an apparatus invented in 1879 by Hess, while the second method used the Brisanzmesser nach Kast, an apparatus invented in 1913 by Kast.

Both of these methods are described by Stettbacher (Refs 1 and 2) and in the general section under Brisance Determinations.

References:

1) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), pp 365-368

2) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), pp 113-115.

Steel and Iron Ammunition Items. Nearly all of the smaller ammunition items (such as bullets, caps, cartridge cases, etc) of the pre- WW II period were manufactured from nonferrous metals or alloys such as copper, lead, nickel, brass, gilding metal, etc. Due to the acute shortage of the above metals which developed at the beginning of WW II, it was found necessary to replace them by the ferrous metals such as steel or iron.

The following ammunition items made of steel or iron by the Deutsche Waffen- und Munitionsfabriken A -G, Schlutup bei Lübeck, are described by H.Peploe et al, CIOS Report 33-20 (1945), pp 7-22, 30-38 & 48-50:

a) SmE (Spitzgeschoss mit Eisenkern) Bullet, consisted of an iron (soft steel) core surrounded by a lead jacket surrounded by a steel envelope zincated on the outside (pp 17 & 30)

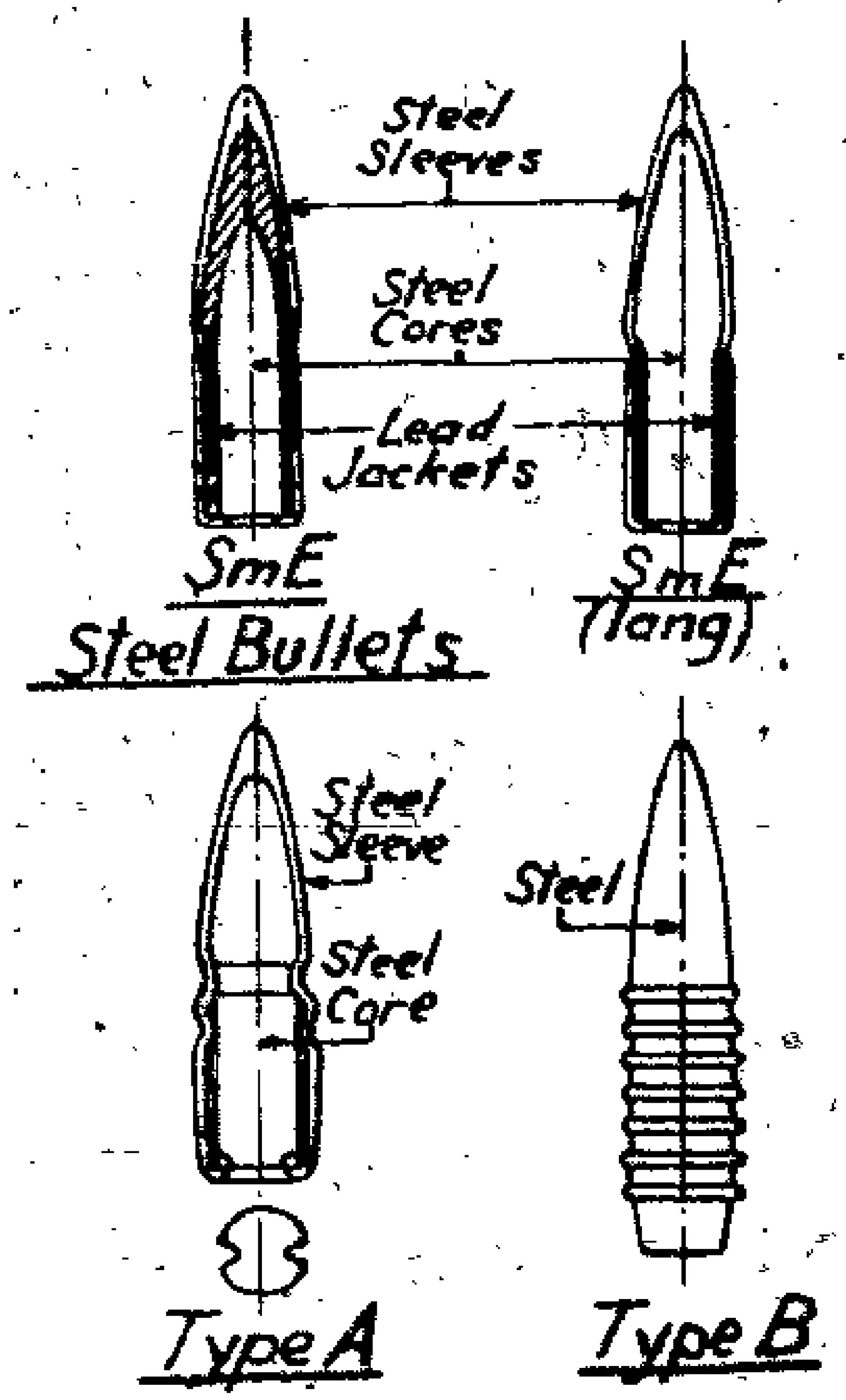
b) SmE (lang) [Spitzgeschoss mit Eisenkern (lang)] Bullet, was similar to the SmE except that the lead sleeve was only in the rear section. In order to compensate for the loss of weight, the length of the iron core was correspondingly increased (pp 17 & 30).

Note: There were also armor-piercing bullets, one with a steel core (Spitzgeschoss mit Stahlkern) and another with a tungsten carbide core (Spitzgeschoss mit Stahlkern, Gehärtet). They are briefly described under Small Arms Ammunition.

c) Steel (Leadless) Bullet, Type A, consisted of a steel core surrounded by a steel envelope. In this bullet an attempt was made to cushion it (while in the bore) on a film of gas. For this purpose, two slots were made in the base of the core in order to allow inflow of gases on firing. The core was also cannelured and the envelope had two cannelures, one to key it to the core, the other for attaching the cartridge case. It was claimed that the barrel life with this bullet was about 5000 rounds (p 30)

d) Steel (Leadless) Bullet, Type B, was a zinc-coated, turned steel slug with the bearing surface considerably reduced in comparison with ordinary bullets. Barrel life with this bullet was claimed to be about 3000 rounds, but could be increased by lubricating the bullet (p 30).

Steel Cap manufacture is briefly described on pp 36-7. The caps were zincated and then internally varnished previous to filling them with the following mixture: Pb styphnate 40, Ba nitrate 42, Ca silicide 10, Tetracene 3 and Pb peroxide 5%. Steel Cartridge Case manufacture is briefly described on pp 8-16 and 48-50.



(See also under Cartridge Cases, Steel).

It should be noted that the Germans developed the technique of making sintered iron bullets (see under Pulvermetallurgie) and also a process for covering the steel projectiles with sintered iron or steel, described briefly in this work under Tiefbooder Verfahren.

Stick Grenade. See Rodded Bomb.

Stick Handgrenade. See Potato Masher Grenade.

Stielhandgranate (Stick Hand Grenade). See Potato Masher Grenade.

Stockmine. See under Landminen and also on p 277 of TM 9-1985-2 (1953).

Stonit (Stonite). One of the Carbonit-type explosives manufd about 50 years ago in Germany and admitted to England. It consisted of NG 68, kieselguhr 20, wood meal 4, and K or Ba nitrate with Mg carbonate 8%. To this could be added some sulfonated oil, or lard [Daniel, Dictionnaire, Paris (1902), p 739].

Storm Matches. According to BIOS Final Rept 1313 (1947), these matches were manufactured by the Deutsches Zündwaren Monopole at Lüneburg. No description of match compositions is given.

Streckungsmittel oder Streckmittel (Extender, called also Stretcher, Filler or Diluting Agent). In order to combat the shortage of aromatic nitrocompound explosives (such as TNT), the Germans incorporated some non-explosive materials which served to increase the bulk of the explosive. The most common of such extenders were

oxidizing agents, such as Am, K, or Na nitrates. These substances were not inert as they supplied oxygen to oxygen defficient aromatic nitrocompounds, such as TNT. Other German extenders, such as Na chloride, being neither oxidizers nor combustibles were not as useful, although it was claimed that mixtures of TNT/NaCl - 50/50 or 40/60 developed considerable gas pressure on explosion.

Explosive compositions in which extenders were used were called Ersatzsprengstoffe (q v).

Reference: PB Rept 85,160 (1946), p 7.

"Strassburg-Kehl" Guidance System. See under Guidance Systems for Missiles.

Streubrand C 500 (Container for Scattering Incendiary Bombs). It consisted of a metallic tube, divided along its longitudinal axis into two sections welded together, with a primacord running alongside the seam. A delay fuze with a gaine were attached to the primacord. The container was filled with 1200 green incendiary boxes immersed in water. On release of the container, the fuze was charged and, after a short delay, it fired and detonated the gaine and the primacord. The detonating wave travelled alongside the seam and caused the separation of the two halves of the container thus scattering the incendiary boxes over a target. This device did not work very satisfactorily.

Reference: TM 9-1985-2 (1953), p 117.

Structural Explosives (Blast Effect Explosives). At the time of the development of rockets in Germany (during WW II) the military authorities requested the Krümmel Fabrik, D A -G, to produce high explosive charges which could be used as missiles without being confined in steel casings and thus to save dead weight. It was suggested by the Krümmel Fabrik that material consisting of layers of paper 20 parts, impregnated with 80 pts of molten TNT, previously mixed with RDX and NC, be used for the construction of such projectiles. The other suggestion was to combine synthetic resins (thermoplastic and thermosetting) with RDX and to use this mixture as the HE for such projectiles (Ref 1).

It is to be noted that such projectiles produced high blast effects (Luftdruckwirkung oder Luftstoss), but comparatively low shattering effect, called also brisance (Brisanz). Practically the same kind of blast effect was achieved with a HE in bombs constructed by filling a thin, light, metallic case, strong enough to withstand handling and shipping but too weak to withstand impact with target. These bombs (called in the U S A the light case bombs) were of very high capacity (about 80%) and caused considerable damage by blast effect alone, especially in residential sections. They were fuzed for superquick or non-delay action.

The larger size bombs were called "blockbusters" in Great Britain and the U S A.

References:

1) O.W.Strickland, PB Rept 925 (1945), Appendix 7

2) T.C.Ohart, Elements of Ammunition, Wiley (1946), p 227.

Stubenrauch Explosives. A series of explosives patented at the end of the last century by von Stubenrauch of Rastatt. One of his explosives was prepared by blending K chlorate 80 with 0.5-1.0% of Ca carbonate (or Mg oxide) and with a mixture prepared by treating the hot pulverized charcoal with tar (goudron) previously dehydrated and desulfurated. [J.Daniel, Dictionnaire des Matières Explosives, Paris (1902), p 795, under Von Stubenrauch].

Sturmmörser (Assault Mortar). A self-propelled mount consisting of a 380 mm rocket projector on PzKpfw VI(E) (See also under Panzer).

Styphninsäure (Styphnic Acid). See Trizin.

Submachine Gun or Light Machine Gun. See under Weapons. The Automatic Pistols (Maschinenpistolen) provided with shoulder attachments may also be called Submachine Guns.

Submarine 21. See U-Boat 21.

Submarine, One Man. See U-Boat, One Man.

Submarine, Pocket. See Seehund.

Submarine, Walter. See U-Boat Walter.

Sulfuric Acid (Schwefelsäure). Preparation, properties and uses are given in the general section. The contact method, using a vanadium catalyst, was the most common in Germany, but some plants used the old chamber process and at least one plant used the wet contact process utilizing hydrogen sulfide. The Chemische Düngerfabrik A -G used the so-called Peterson Tower Process installed by the Lurgi Apparatebau A -G. In all of these methods sulfur was the primary material. Inasmuch as sulfur was not plentiful during WW II, a special process (Splitting or Cracking Process) which permitted the recovery of sulfur in the form of sulfur trioxide from waste weak sulfuric acids was developed and constructed by Lurgi Co (See under Lurgi Cracking Plant). This new process of manufacture of oleum was used by several German factories but it is doubtful (see Ref 13) if the process would be economical in peace time when sulfur is plentiful. Another sulfur saving process is briefly described under Sulfur Recovery.

The number of German sulfuric acid plants was very great but the following plants, briefly described in various BIOS Reports, may be considered as typical:

a) A -G des Altenbergs für Bergbau- und Zinkhüttenbetrieb, Essen-Bergeborbeck (Chamber and contact process plants) (Ref 7)

b) Berzelius Metallhütten GmbH, Duisburg-Wanheim (Chamber process plant) (Ref 6)

c) Chemische Düngerfabrik, ~~Rendsburg~~ (Peterson Tower process) (Ref 9)

d) Chemische Fabrik Wesseling A -G, Wesseling bei Köln (Chamber process sulfuric acid plant and also a sulfur recovery plant from spent oxides by the method of Dr Jakob) (Ref 11)

e) Dynamit A -G plant at Leverkusen-Schlebusch (Contact process) (Ref 5)

f) Gaswerke Frankfurt a/Main (Wet contact process from hydrogen sulfide) (Ref 12)

g) IG Farbenindustrie A -G, Leverkusen (Contact process) (Ref 4)

h) Krümmel-Geestacht Fabrik of D A -G (Contact process) (Ref 10)

i) Lurgi Chemie A -G, Frankfurt a/Main (Contact process and Lurgi Cracking Unit) (Ref 3)

j) Norddeutsche Affinerie, Hamburg (Contact process) (Ref 8)

References: BIOS Final Reports: 1) 244 (1945), 2) 1623 (1947), 3) 1631 (1948), 4) 1633 (1948), 5) 1634 (1948), 6) 1636 (1948), 7) 1639 (1948), 8) 1641 (1948), 9) 1642 (1948), 10) 1643 (1948), 11) 1644 (1948), 12) 1645 (1948) and 13) PB Rept 925 (1945), p 25.

Sulfur Monochloride - Vegetable Oil Dynamites were prepared beginning about 1898, by the Chemiche Fabrik at Winkel on Rhine by mixing NG with rubber-like products obtained on treating vegetable oils (such as linseed oil) with sulfur monochloride, S_2Cl_2. Other ingredients, such as TNT, P A, etc could be incorporated.

Similar explosives were prepared by Bielefeldt.

Reference: J.Daniel, Dictionnaire, Paris (1902), pp 71 & 134.

Sulfur Recovery from Spent Iron Oxides. To reduce the shortage of sulfur (so essential for the manufacture of sulfuric acid) the Chemische Fabrik Dr Jakob, Bad Kreuznach, before WW II, invented a method of recovery of sulfur from the spent oxides which were used for the purification of gases in the Fischer-Tropsch Process Plants or in the Gas Works. One such installation was at the Chemische Fabrik, Wesseling. It was reported that not less than 65 000 tons of sulfur were recovered annually by this method

of sulfur recovery. (See under Lurgi Cracking Process).

Dr Jakob's Process was essentially as follows:

a) Four vertical cylindrical jacketed extractors, fitted with covers and each containing six trays were loaded with spent oxides (7.5 tons in each vessel) and extracted with carbon disulfide, at 25°, entering each vessel at the top and moving by gravity

b) Of the 4 extractors, 3 were in the extraction cycle and one off for charging or discharging. As a freshly charged extractor was put on the line an extractor containing exhausted oxide, was taken off

c) The freshly charged vessel was first treated with CS_2 rich in sulfur and from there the saturated soln went to a 10 ton capacity water-heated still for distillation, while fresh CS_2 from the head tank entered the most exhausted extractor

d) When the sulfur extraction in the spent oxide had proceeded to the economic limit, the extractor was taken out of the circuit and the CS_2 soln remaining in it removed to the still by direct injection of live steam at 6 atm pressure

e) After removal of the last traces of CS_2, the extractor cover was removed and the nest of trays lifted out

f) Distillation of CS_2 was conducted batchwise at 80-90° and the CS_2 was condensed and collected. When distillation was complete, the temperature in the still was raised to 130° by direct steam and the molten sulfur ran out through a jacketted pipe into a large shallow brick tray in the open air. Venting of the still was done with nitrogen.

A more detailed description of this process is given by H.A.Hoyle et al, BIOS Final Rept 1644 (1948), pp 5-10s

Supergun. See Hochdruckpumpe.

Synoxyd. See Sinoxydsätze.

SV-Stoff und Brennstoff. According to CIOS Rept 30-115 (1945), p 11, the 90/10 mixture of concentrated nitric-sulfuric acid (transported in tanks made of ordinary steel) was used in conjunction with a combustible (Brennstoff), such as gasoline, in liquid rocket propellants. The above acid mixture was known as SV-Stoff. The same name was applied to the straight concentrated nitric acid (such as 98-100%) when used in rockets. This acid was also known as Salbei.

Synthetic Resins and Emulsions used in Germany during WW II for the manufacture of items employed in ammunition, are briefly described in BIOS Final Reports Nos 1715, 1794 and 1795 (1947).

Taifun. An experimental biliquid rocket designed to be fired in groups of 65 from a launching machine known as the Doberän. The missile was about 2.1 m long and 10 cm in diameter, provided with a warhead containing 500 g of HE. It was propelled by a liquid fuel (Visol) and a liquid oxidizer (concentrated nitric acid).

References:
1) CIOS Rept 28-56 (1946), pp 24-28
2) TM 9-1985-2 (1953), p 223.

Tapered Bore Gun (Würgebohrung Geschütz), called also Gerlich Type Gun, Squeeze-Bore or Reducing Bore Gun was developed in Germany in the early stages of WW II. Its barrel consisted of 3 sections (starting from the breech):

a) Cylindrical section, such as 42 mm bore diameter

b) Slightly conical middle section and

c) Cylindrical section, such as 28 mm bore diameter.

There were also guns with diameters 28 mm or 75 mm for (a) section and 20 mm or 55 mm for (c) section.

Because of this construction, the projectile which had a spool-like body, was squeezed to a smaller diameter as it passed from the breech to the muzzle. The idea of this gun was to present a large-cross-sectional area of the projectile to the propellent gases, and to present a small cross-sectional area to the atmosphere in order to reduce air resistance and thus increase the muzzle velocity of the projectile. It was claimed that the most valuable advantage of this type of gun was the possibility of reducing the total length of a bore almost to one-half without any changes in maximum pressure and muzzle velocity and preserving almost the same weight of projectile.

Although this weapon was light and gave comparatively good armor-penetration it was given up for the following reasons:

a) Its manufacture was very difficult

b) It wore out too rapidly

c) Its effective range was rather short.

Some of the tapered-bore guns and their projectiles are on display at the Aberdeen Proving Ground Museum, Maryland.

A short description of such guns is given by:
L.E.Simon, German Research in World War II, J.Wiley, N Y (1947), p 189.

Note: According to E.Engleburg, The Ordnance Sergeant, May 1944, p 312, the inventor of this gun and its projectile was an American born German engineer, H.Gerlich, residing in Kiel. He worked on the development of high velocity weapons and projectiles from about 1920, and in 1932 he demonstrated at Aberdeen Proving Ground, Md a rifle firing a missile with a velocity of about 4445 ft/sec. The rifle was not accepted. After this Gerlich worked for the Germans. The first known combat use of the Gerlich principle was made in the Lybian campaign. The weapon employed in Lybia was the 2.8/2.0 Pak, a light antitank gun mounted on a two-wheeled carriage. In this gun the first 18" of the barrel, beginning from the breech, were of caliber 28 mm, the next 9" of the barrel had a rapid taper of .022" per 1" and in the last 23" of the barrel, the taper decreased to .002"/1". The projectile had no rotating band or bourrelet, but instead had two skirt-like flanges extending away from the body. During the flight of the shell through the tapered bore, the skirts collapsed and a nearly smooth shell of about 20 mm caliber emerged from the muzzle of the gun. It was claimed that muzzle velocities up to 6000 ft/sec could be achieved and that armor penetration at 100 yds was 70 mm for hard steel and 76 mm (3") for machineable plates.

Note: According to TM 9-1985-3 (1955), p 360, the Squeeze-Bore Gun consisted of an ordinary rifled gun to the muzzle of which was attached a smooth-bore tapered extension. This means that there was a difference between the Squeeze-Bore Gun and the Tapered Bore Gun. The projectiles were interchangeable in both cases. The guns and projectiles called "Squeeze-Bore" by the Americans were called "Little-John" by the British.

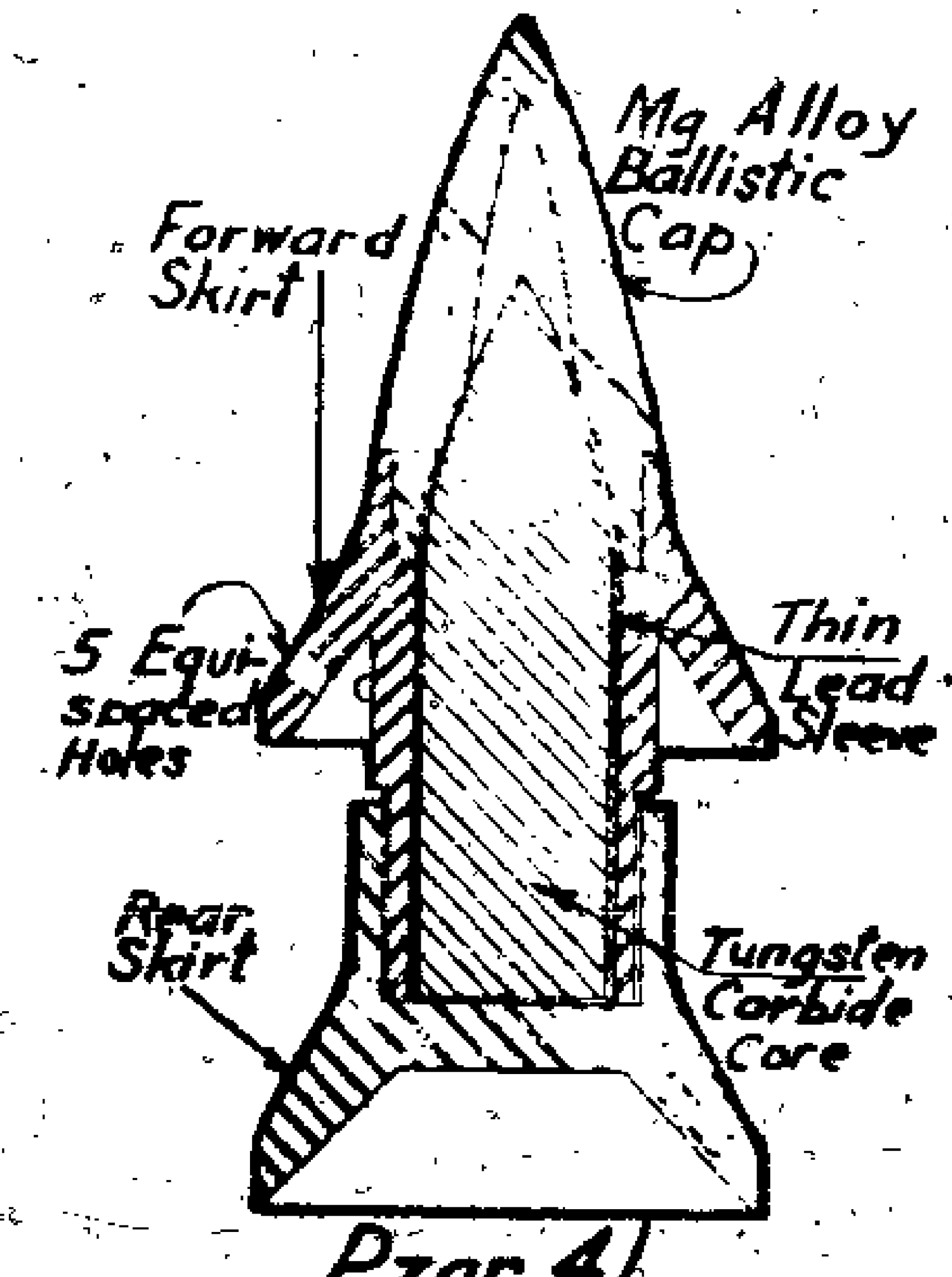
Tapered Bore Gun Projectile or Gerlich Projectile. According to E.Engleburg, Ordnance Sergeant, May 1944, pp 319-13 the typical Gerlich projectile such as the Armor-Piercing Projectile Type 41 (Pzgr 41) used in the 28/20 mm Antitank Gun (2.8/2.0 cm Pak) consisted of the following parts:

a) A tungsten carbide core which had a diameter about half the caliber of the gun at the muzzle and served for the actual penetration into the armor

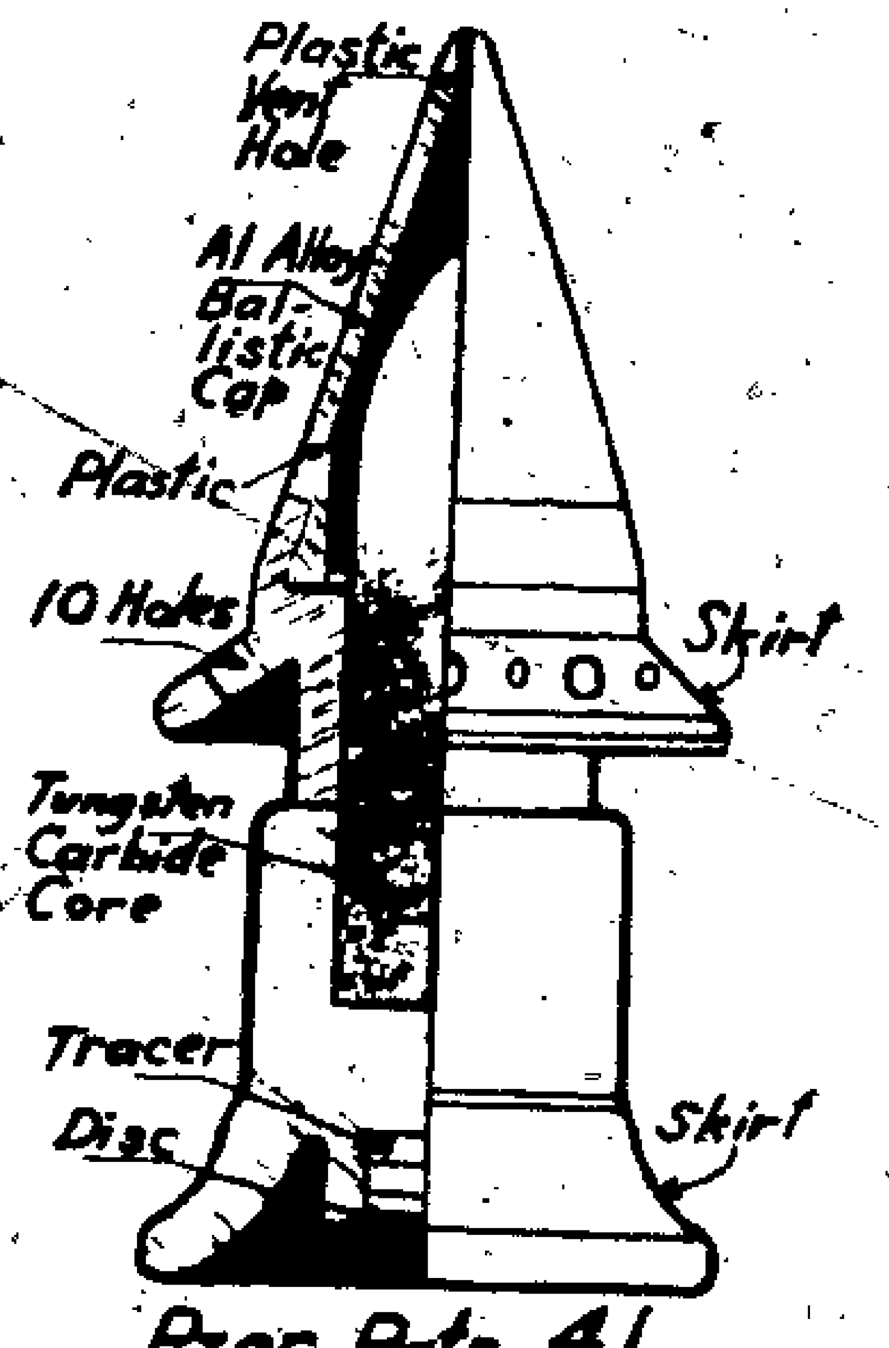
b) A thin lead sleeve which covered the core and held it in place. The sleeve served as a lubricant for the core when the skirts were separating from it on impact

c) A magnesium alloy ballistic cap which fitted snuggly into the forward skirt and served as the nose of the projectile. On impact the Mg alloy produced a flash which permitted observation of the firing

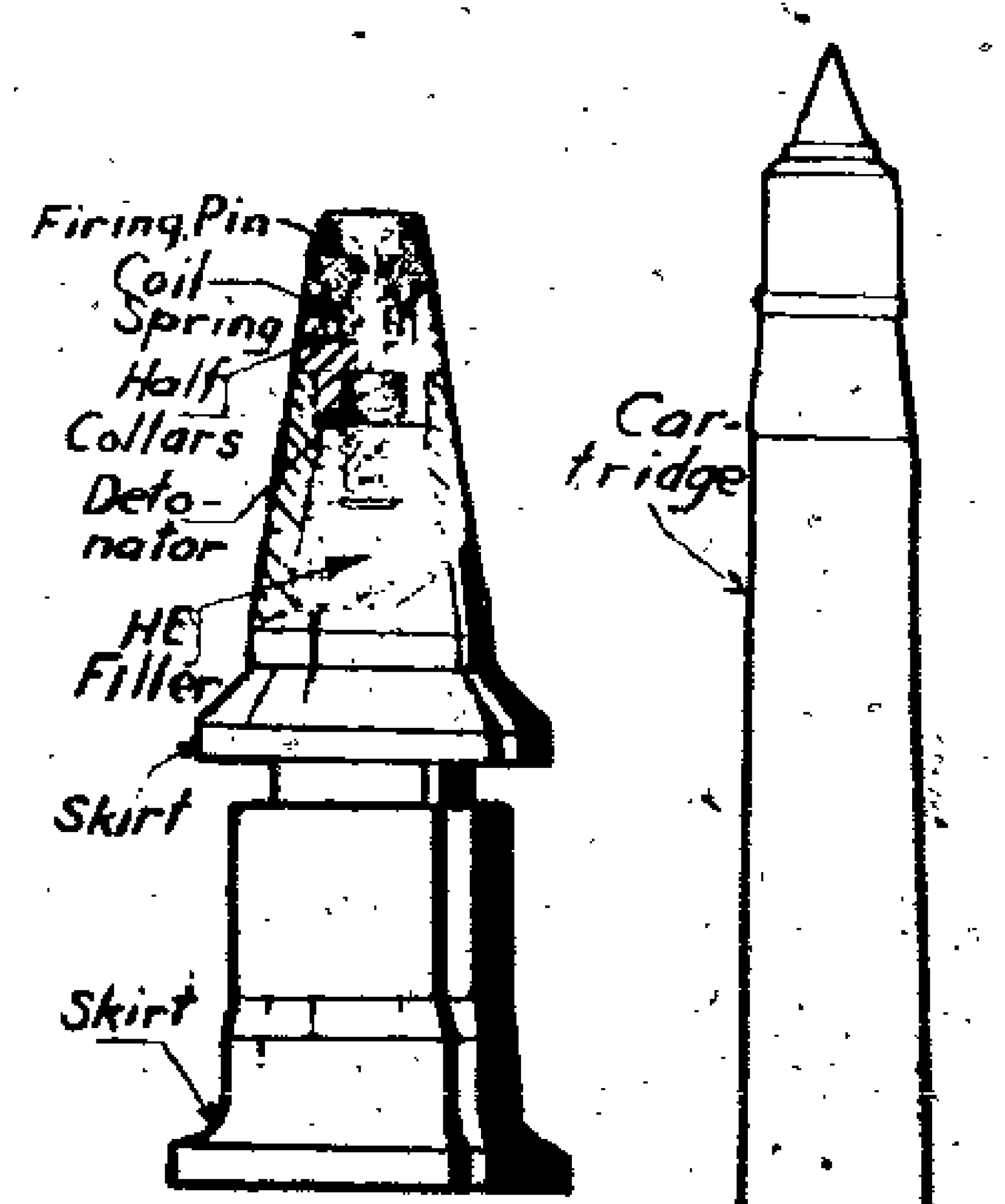
Note: The Mg cap was not used in all tapered bore projectiles, as can be seen from the drawing of PzgrPatr 41. In this projectile the cap is of aluminum and the tracer composition, fitted into the base of projectile, permitted observation of the firing.



Pzgr 41 für 2.8/2.0 Pak



Pzgr Patr 41 (4.2/2.8 cm)



Sprgr 41

d) A forward skirt, which was made of a soft iron or gilding metal and served as the bourrelet of conventional projectiles. The skirt extended as far back as the base of the core and was provided with 5 or more equidistant holes. These perforations were intended to decrease the mass of the skirt and to allow air to escape as the skirt was squeezed back and down into the recess in the projectile casing while travelling through the barrel of the gun. As a result of this squeezing the diameter of projectile decreased.

Note: In contrast to the Disintegrating Rotating Band Projectiles and to some Sabot Projectiles, the bands (skirt) of the Gerlich projectile did not break nor detach. They simply squeezed to the diameter of the muzzle.

e) A rear skirt, which was made of a soft iron or gilding metal (which served as the driving band of conventional projectiles) extended away from the body and was squeezed down and back in travelling through the barrel.

Note: The penetration of the 2.8/2.0 cm Pzgr into armor plate was about 3" at a range of about 100 yards and a muzzle velocity of 4600 ft/sec. For the 4.2/2.8 cm Pzgr the penetration was 4.52" at 200 yd and a muzzle vel of 4600 ft/sec, and for the 7.5/5.5 cm Pzgr the corresponding values were 6.67", 500 yd and 3936 ft/sec. In all cases the guns were antitank, such as 2.8/2.0 Pak, 4.2/2.8 Pak.

Somewhat different was the construction of the High Explosive Projectile, such as the Sprgr 41. The forward part of this shell was flat and there was no ballistic cap. In place of the tungsten carbide core of Pzgr 41, the interior of Sprgr 41 was filled with a HE (such as Cyclonite) which was provided with a point detonating fuze. The forward and rear skirts were similar to those of the Pzgr 41 and served the same purpose. The fuze of the Sprgr 41 was bore-safe and before firing a single coil spring kept two half-collars squeezed against the firing pin, thus preventing it from being depressed. In flight, the centrifugal force created by the rotation of the projectile forced the two half-collars apart, and the firing pin was then free to move toward the detonator on impact. The Sprgr 41 was used against personnel and light material targets.

Note: The above described Armor-Piercing projectiles had arrowhead design heads and for this reason can be classified as Arrowhead (Needle Point) Projectiles (q v).

The advantages and disadvantages of the tapered-bore gun and its projectile are listed above under Tapered Bore Gun.

The projectiles used in tapered-bore guns are also described in the following References:
1) R.M.Dennis, Pic Arsn Tech Rept 1326 (1944) (42/28 mm APHV)
2) A.B.Schilling, Ibid, 1578 (1945) (75/55 mm HE Shell for Tapered Bore Gun, Pak 41)
3) A.B.Schilling, Ibid, 1579 (1945) (75/55 mm AP Shell for Tapered Bore Gun, Pak 41)
4) Dept of the Army Tech Manual, TM 9-1985-3 (1953), pp 371-372: 28/20 mm HE, 28/20 mm, 42-28 mm HE and 42/28 mm AP projectiles.

Terben. See under Trilona.

Target Indicating Flare, Mark 50 Koskode, and Target Indicator (Red) are described in TM 9-1985-2 (1953), pp 71-3 84-5 (See also under Flare and under Marker).

Teilladung (Increment). See under Cordite Charge Casing.

Television Guidance System for Missiles. See under Guidance Systems for Missiles.

Tellerapparate oder Heizbare Mischmaschine (Plate Apparatus or Heatable Mixing Machine). An apparatus suitable for mixing solid and liquid ingredients of explosives, propellants and pyrotechnic compositions. It consisted of a large horizontal, cast iron, steam-jacketed, cylindrical pan on which the materials were placed. These were crushed and mixed by the combined action of a long, small diameter, horizontal roller (made from a non-sparking metal, such as Cu, brass, or Al) rotating around the center of the base at the rate of ca 3 rpm and a series of scrapers (made from non-sparking metal) following behind the roller. The scraped material was reground by the roller and then again rescraped and this action continued until all the ingredients were well mixed.

The apparatus was manufd before WW II by the Gebr Burberg, Mertmann, and could be operated either in the cold, or heated by steam.

Reference: Stettbacher, Schiess- und Sprengstoffe, Leipzig, (1933), pp 301-2.

Tellermine (Dish-like Land Mine). According to Simon (Ref 1) these mines gave the Allies considerable trouble throughout WW II. They were sufficiently powerful to put a tank out of action and to wreck almost any other vehicle. The first of such A/T mines, called Tellermine 35, was made of steel, while the models developed towards the end of WW II were made of non-magnetic materials to render mine detectors ineffective. Some of the latest mines were reported to be remote-controlled but it is not known whether they were actually used in combat.

The following models are described in Ref 2: Tellermine 35 A/T (p 267); Tellermine 35 (Steel) A/T, (p 268), Tellermine 42 A/T (p 269) and Tellermine 43, Pilz, A/T (p 270) (Pilz means mushroom).

Essentially the body of the mine was a circular, flat, dish-like form with a hole in the center of the cover. The body was loaded with 11-12 lb of compressed high explosive (such as TNT) and an igniter was screwed into the cover. A second (floating) cover was held down by a metal ring attached to the body and was supported in the center by a heavy spring. A pressure of 200-400 lbs on the "floating" cover was sufficient to depress it as well as the igniter housing. The pressure of the housing on the top of the striker sheared the pin which held the striker in the cocked position, thus releasing the striker spring. As a result of this the striker set off the percussion cap, detonator, booster and the main charge such as of TNT.

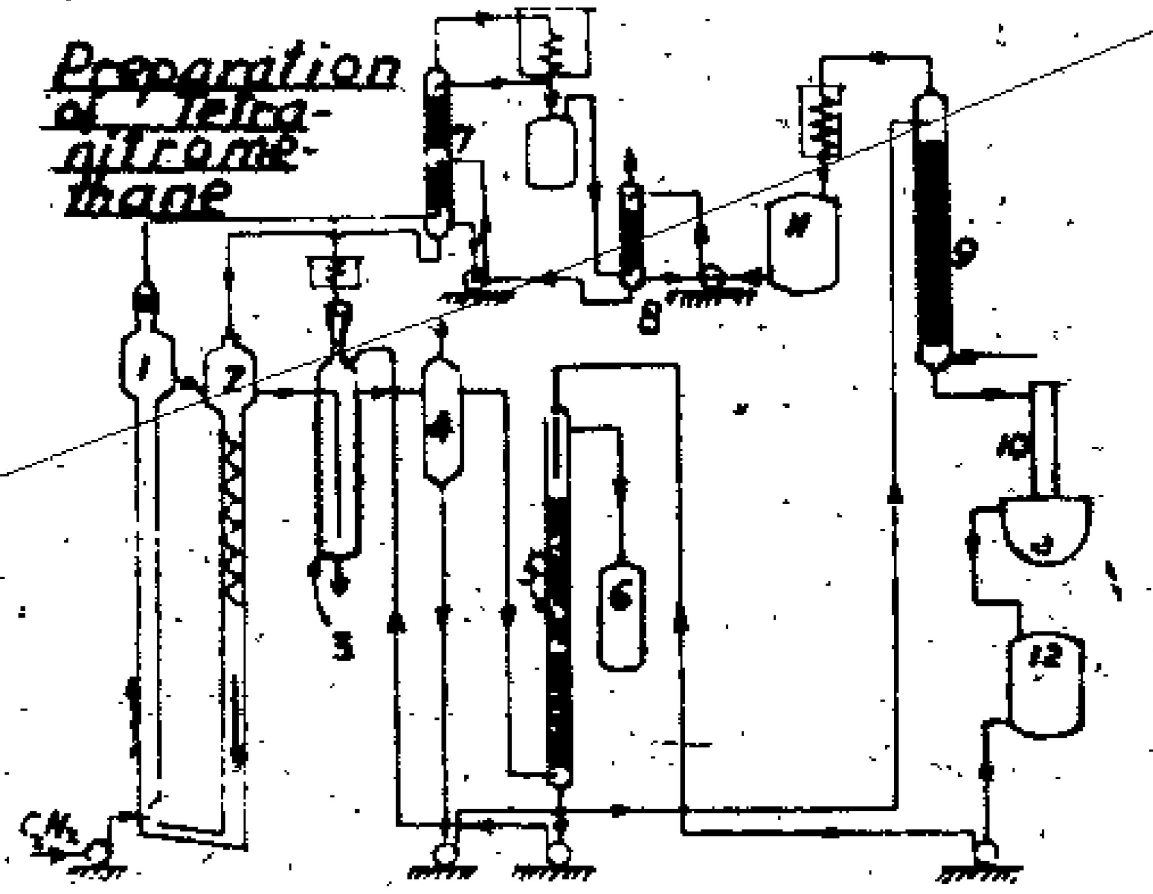
References:
1) L.E.Simon, German Research in WW II, Wiley, N Y (1947), p 188
2) Anon, German Explosive Ordnance, Dept of the Army, Tech Manual TM 9-1985-2, Washington, D C (1953), pp 267-70.
(See also under Landminen).

Testing Gallery (Schlagwetterversuchsstrecke). See general section, under Galleries, Testing and also this section under Versuchsstrecke.

Tetan oder X-Stoff (Tetranitromethane, abbreviated in this work as TeNM or TeNMe). A detailed description of the preparation, properties and uses of TeNMe is given in the general section under Methane. The following description concerns the German method of preparation and uses of TeNMe.

As the classical method of prepn of TeNMe from acetic anhydride and nitric acid (see general section) is very expensive, a new method was developed during WW II by Dr Schimmelschmidt (Refs 1 & 2). The laboratory scale procedure was as follows:

In an all-glass apparatus, schematically represented on the enclosed drawing, acetylene reacted with nitric acid to give nitroform and the mixture of nitroform and nitric acid yielded TeNMe on heating with sulfuric acid. The reaction was believed to proceed as follows:



$CH{:}CH + 2HNO_3 = (O_2N)_2CH.CHO + H_2O$
$(O_2N)_2CH.CHO + HNO_3 = (O_2N)_3C.CHO + H_2O$
$(O_2N)_3C.CHO + 2HNO_3 = (O_2N)_3C.COOH + 2NO_2 + H_2O$
$(O_2N)_3C.COOH = (O_2N)_3CH + CO_2$
$(O_2N)_3CH + HNO_3 = (O_2N)_4C + H_2O$

$CH{:}CH + 6HNO_3 = (O_2N)_4C + 4H_2O + 2NO_2 + CO_2$

About 60% of acetylene reacted as above and about 40% underwent complete oxidation according to the equations $CH{:}CH + 10HNO_3 = 2CO_2 + 10NO_2 + 6H_2O$, so that the over-

all equation could be represented by:
$5C_2H_2 + 38HNO_3 = 3(O_2N)_4C + 24H_2O + 7CO_2 + 26NO_2$.

The recovery of nitrogen dioxide and of unconverted nitric acid was about 96% of theory.

In this procedure the acetylene gas, C_2H_2, was introduced at the lowest point of the system at the rate of 93.5 liters per hour and the nitric acid (98%) containing mercuric nitrate as a catalyst, was fed at the rate of 2.4 liters per hour.

Note: The catalyst was prepared by dissolving 70 g of mercury in about 500 ml of 89% nitric acid, adding 300 ml of water and making up to 1 liter with 89% nitric acid. Twenty ml of this soln was added to every 10 liters of 98% nitric acid fed.

By circulating cold water through the cooling coil, located in the 2nd leg of the reaction system, a temperature of 50° was maintained. The solution of nitroform in nitric acid overflowed from the circulating system to three nitration vessels (3) placed in series, each nitrator being heated by a steam jacket. The sulfuric acid from the TeNMe purifying tower (5) together with the nitroform mixture flowed into the 1st nitrator and the tetranitromethane and remaining acid overflowed from the 3rd nitrator. The temperature in each nitrator was maintained at 90° and the contact time of nitration was about 4 hours. Each nitrator was provided with a reflux condenser for returning TeNMe and HNO_3 as well as any condensable gases such as N_2O_4.

The warm mixture leaving the 3rd nitrator quickly separated in (4) and the top layer of TeNMe was fed continuously to the purification tower (5). The feed of 95.5% sulfuric acid to the purification tower (5) was 1.7 l per hour and the run-off product was charged to the nitrators (3). Pure TeNMe left the top of the purification tower (5) at the rate of 440-460 g per hour and was collected in a tank (6).

The off-gases of the nitration system [such as N_2O_4, CO_2 with small amounts of HNO_3, $C(NO_2)_4$, $CH(NO_2)_3$ and possibly unreacted C_2H_2] passed to the purification column (7) which was divided into 2 sections. In the lower section the last traces of C_2H_2 were removed by scrubbing with warm nitric acid (containing mercuric nitrate) fed at the rate of 2.4 l per hour. In the upper section of column (7) nitrogen dioxide and carbon dioxide were separated by distillation and the nitrogen oxide was condensed, in the pure form, by a mixture of solid CO_2 and acetone. The gases leaving the receiver were scrubbed in a smaller column (8) by cold nitric acid (to remove the last traces of nitrogen dioxide) and the nitric acid run-off was fed to column (7), whereas the CO_2 was allowed to escape.

The nitric acid (which contained sulfuric acid, nitrogen dioxide and tetranitromethane) was separated from sulfuric acid by distillation in column (9) and condensed in tank (11). The residue, consisting of 70% sulfuric acid, was concentrated to 95.5% strength in the Pauling column (11) and collected in tank (12).

Note: Although the attached diagram indicates a continuous system for the separation and concentration of mixed acid from the separated TeNMe, the process was actually conducted batchwise, as sufficient material accumulated.

TeNMe was proposed as a base for very powerful and brisant explosives, called in Germany Tetan Sprengstoffe (q v), and also as an oxygen carrier in liquid rocket propellants to replace the corrosive strong nitric acid. Due to the fact that the freezing point of TeNMe is fairly high (about 14° C), it was proposed by Drs Schultheiss and Schimmelschmidt to mix 70 parts of TeNMe with 30 p of nitrogen tetroxide. This mixture had a freezing point of -27° and was non-corrosive, provided no moisture was present. It was proposed to use this mixture in V-2 rockets (Ref 2).

References:
1) R.E.Richardson et al, CIOS Report 25-18 (1945), pp 6-14
2) W.Hunter et al, BIOS Final Report 70 (1946), pp 1-6.

Tetan Sprengstoffe (Tetranitromethane Explosives). It was mentioned under Ersatzsprengstoffe that, due to the acute shortage of TNT and of other high explosives, the Germans used during WW II, as ingredients of explosive mixtures, substances which were not explosives. Among such substances was TeNMe (tetranitromethane), called in Germany Tetan, a liquid waste product of the manufacture of TNT.

The first Tetan mixture consisted of very finely pulverized aluminum (called Pyroschliff), impregnated with TeNMe, and a small amount of the following substances: a hydrocarbon rich in hydrogen and a consolidating compound called "K_3", which was a high dispersion of silica prepared by a special process. The hydrocarbon was added in order to increase the sensitivity to initiation. This Tetan explosive was a solid possessing a very high blast effect and a comparatively low velocity of detonation. Explosives with such properties were found to be suitable for underwater explosions (Ref 1).

Other explosive mixtures consisted of Tetan with liquid or pulverized carbon containing substances, such as hydrocarbons, coal, charcoal, nitrocompounds, etc. Some of these mixtures were more powerful and brisant than TNT, P A, PETN or RDX, and were particularly suitable for underwater explosions.

Considerable work on this subject was done by Dr A.Stettbacher (See general section under Methane). One of the most powerful and brisant explosives known is a mixture of Tetan with toluene. Its velocity of detonation is about 9300 m/sec.

There were also explosives prepared from derivatives of TeNMe, as for instance the perchloric ester of trinitroethanol. The trinitroethanol (m p 70°) was prepd by condensing nitroform (derived from TeNMe) with 40% solution of formaldehyde.

References:
1) G.Römer, PBL Report 85,160 (1945), pp 2-3
2) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig, (1933), p 185 and Ibid, Spreng- und Schiesstoffe, Zürich (1948), pp 10, 16 & 148.

Tetrocene (Tetrazen) was prepd in Germany utilizing the same equipment as used for prepn of L A and L St.

The procedure was as follows:

a) To a solution containing 4.0 kg of Na nitrite and 1.5 liters of normal acetic acid in 60 liters of water preheated to 50°, was added gradually and with air agitation 40 liters of an aqueous solution of 5.3 kg of aminoguanidine sulfate. The addition took one hour

b) After stirring the mixture for an additional hour at 50° and for 1 hour at 20°, the reactor was tipped and the contents caught on a filter cloth made of horse hair

c) After washing the ppt with several portions of water, it was dried in the same manner as described under lead azide. This gave about 3.0 kg of dry tetracene

d) Boiling the mother liquor for several hours was sufficient to destroy any waste tetracene remaining in it.

A similar method, used at the Fabrik Wolfratshausen Chemische Erzeugnisse and at the Stadeln Fabrik, Dynamit A-G, is described by Sheldon (Ref 3). In this description the following details of the method which are worthy of mention are given:

A. A solution of aminoguanidine sulfate (5 kg per 40 l of water) was neutralized (to the litmus paper end point) with either acetic or nitric acid and then added to a preheated solution of Na nitrite (2.5 kg per 50 l of water). If the addition rate was rapid, small, slow settling crystals of Tetracene were produced and if the addition rate was slow (2 hours), larger and faster settling crystals resulted.

B. The detailed procedure was as follows: A temperature of 50 to 55° was maintained throughout the entire reaction period which was allowed to proceed 30 minutes after the last of the aminoguanidine sulfate solution had been added to the reactor. Then the agitator was stopped, the product allowed to settle and the mother liquor removed

by decantation.
C. After the decantation of the mother liquor, one dilution was given and then the precipitate was flushed from the tilted reactor onto a large cloth supported on a natural drainage filter (as for lead azide). After three additional displacement washes, the cloth was folded over the tetracene and the ensemble placed in a plastic bucket to be transferred to the storage area.
D. For Tetracene, which had to be dried prior to use, the washing on the cloth was followed by washing with some 96% ethyl alcohol containing some methyl alcohol. After dehydrating with alcohol, the cloth was folded over the material which was then placed in a plastic bucket and transferred to the storage area.
E. The yield of Tetracene when using 4.0 kg of aminoguanidine sulfate was 2.6 to 2.7 kg.

The following priming mixtures containing Tetracene are listed in Ref 3:
I. Priming Mixture No 30/40, used for rifle and pistol cartridges: Tetracene 3, Pb styphnate 40, Ba nitrate 42, Ca silicide 10 and Pb dioxide 5%.
II. Duplex-Cap Mixture for use in 20 mm and 37 mm, as well as in some larger shells, consisted of 0.30 g of Pb azide 92.5 and Tetracene 7.5% pressed at 100 kg/cm² over 0.05 g of unwaxed PETN pressed at 500 kg/cm².
III. Priming Mixtures used for pistol and rifle cartridges: Tetracene 2-3, Pb azide 30-35, Ba nitrate 40-45, Ca silicide 6-12, Pb peroxide 5-8 and Sb sulfide 6-9%.

Tetracene was used in initiating mixtures called Sinoxydsätze.
(See also Tetracene in the general section).
References:
1) PB Rept 95,613 (1947), Section R
2) A.Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), pp 98 and 107
3) L.M.Sheldon, CIOS Report 27-38 (1945), pp 9, 11 & 13-14.

Tetra-Di-Salz (Tetra-Di-Salt), described in the general section as Tetramethylammonium Dinitrate, was prepared in Germany by dissolving the Tetra-Salz (see below) in hot 60% nitric acid and allowing the solution to cool. The crystals obtained by filtering were dried in a vacuum. The salt was stable at temperatures up to 100°. Its mixtures with ammonium nitrate and a small amount of RDX were found to be suitable for filling projectiles.
(See also general section).
Reference:
PB Rept 78,271 (1947), p 22.

Tetrahydrofuran (Tetrahydrofurane) is described in the general section. Tetrahydrofurane and its intermediates were produced during WW II by the IG Farbenindustrie at Ludwigshafen.
Reference: CIOS Report 29-12 (1946).

Tetramethylammonium Dinitrate. Same as Tetra-Di-Salz.

Tetramethylammonium Nitrate. Same as Tetra-Salz.

Tetramethylnitraminotetramethylmethane. See in the general section under T. This compound was suggested as an ingredient of explosives containing R-Salz but was not found as satisfactory as dimethylethylenedinitramine.
Reference: G.Römer, PBL Rept 85,160 (1946), p 16.

2,4,6,8-Tetranitramino-1,3,5,7,9-pentamethylene-1,9-dinitrate $(O_2NO)CH_2 \cdot N(NO_2) \cdot CH_2 \cdot N(NO_2) \cdot CH_2 \cdot N(NO_2) \cdot CH_2 \cdot N(NO_2) - CH_2(ONO_2)$, crystals, mp 211°. Was obtained during WW II as a by-product of manufacture of RDX using either the E-Salz or K-Salz process. Both of these processes are described in this German section under Hexogen. The power of tetranitraminopentamethylene dinitrate, as judged by the Trauzl Test, was claimed to be higher than for RDX.
Reference: G.Römer, PBL Rept 85,160 (1946), p 16.

Tetranitrocarbazol oder Gelbmehl (Tetranitrocarbazole or Yellow Flour, abbreviated in this work as TeNCbz). Its preparation, properties and uses are described in the general section under Carbazole.
TeNCbz was proposed during WW II in Germany as a substitute for black powder in illuminating flares of the rocket type (Ref 1). Due to the fact that TeNCbz was non-hygroscopic and non-corrosive it was expected to completely replace the black powder in igniter compositions (Ref 2).
According to Ref 2, the Germans, prior to 1945, used black powder as the main ingredient of their pyrotechnic "intermediate" igniter compositions and it was observed that their storage in contact with magnesium containing flare or star compositions (such as Mg 20, Ba nitrate 57 and chlorinated polyvinyl chloride 23%) resulted in deterioration of the pyrotechnic devices. This was caused by the interaction between the sulfur (of black powder), magnesium (of the flare or star) and moisture (of atmosphere), giving hydrogen sulfide and magnesium oxide. On further storage, the hydrogen sulfide attacked the lead salts (such as Pb azide or Pb styphnate) of the primer thus rendering them unserviceable.
To avoid the destruction in storage of pyrotechnic devices containing magnesium, it was proposed, in 1945, to replace the black powder type "intermediate" composition by the following mixture: TeNCbz 30, K nitrate 40 and Al powder 30%.
References:
1) R.E.Richardson, CIOS Rept 25-18 (1945), pp 27-8
2) H.J.Eppig, CIOS Rept 32-56 (1945), pp 14-15.

Tetranitromethane (TeNMe). See Tetan oder X-Stoff.

Tetranitrodiphenylaminsulfon oder Gelbmehl S (Tetranitrodiphenylamine-sulfone Yellow Flour S). See general section under Diphenylamine. It was proposed, during WW II in Germany, as a substitute for black powder (See also GP Powder and Tetranitrocarbazol).
Reference: CIOS Rept 25-18 (1945), pp 27-28.

Tetra-Salz (Tetra-Salt) is described in the general section under Tetramethylammonium Nitrate. This substance is not an explosive by itself, but it forms powerful explosive compositions when mixed with oxidizing agents such as nitrates. It was prepd in Germany in the pure state by the interaction of methyl nitrate with trimethylamine. The mixtures of Tetra-Salt with nitrates were found to be suitable for filling projectiles and for making propellants for cannon, as well as for rockets.
References:
1) PB Rept 85,160 (1946) 2) PB Rept 78,271 (1947).

Tetra-Salz-Perchlorat (Tetra-Salt-Perchlorate). This compound practically insoluble in water, was obtained by treating TETRA-Salz with perchloric acid. When ignited the substance burned with a small bluish-white, sparkling flame. This behavior suggests that it might be useful in pyrotechnic compositions.
Reference: PB Rept 78,271 (1947), p 21.

Tetryl (2,4,6-Trinitrophenylmethylnitramine) is described in the general section. Used by the Germans during WW II as a sub-booster in some projectiles and as a bursting charge in some land mines.

Following is a brief description of the semi-continuous method of manufacture as used at the Troisdorf Fabrik, D A -G. The installation consisted of two stainless steel nitrators, several stabilizers and one crystallizer.

a) After adding 60 liters of mixed nitric-sulfuric acid to the first vessel and starting the agitation, the nitration was conducted by continuously adding equal volumes of a sulfuric acid solution of dinitromethylaniline and mixed acid, as above. The temperature was maintained at 40°C
b) The slurry of tetryl and acid was run continuously into the 2nd vessel where the temperature was maintained at 25°
c) The contents of the 2nd vessel were run continuously through a stainless steel sleeve where crude tetryl separated from the spent acid
d) By means of a large amount of water, the crude tetryl was transferred to a series of stabilizers where it was washed, first with water, then with a dilute soda ash solution and again with water
e) The moist tetryl was recrystallized from acetone by a special process (very vaguely described) and then dried and screened.

According to BIOS Final Rept 644 (1945) Tetryl was also used in Eschbach Gasless Electric Delay Detonators manufd at the Troisdorf Fabrik, D A -G.
References:
1) PB Rept 95,613 (1947), Section S
~~2) Stettbacher, Spreng- und Schiesstoffe (1948), pp [illegible]~~

"Thor" and "Karl" Mortars were actually heavy, short barrel howitzers, designed by Krupp Co for the destruction of very strong fortifications. In some ways these weapons resembled the Big Bertha (420 mm = 16.5") gun used during WW I. The Thor and Karl weapons were furnished in two calibers, 540 mm and 610 mm. The 610 mm barrel was 8 calibers long and fired a 4400 lb shell to a distance of nearly 4 miles. In order to increase the range, the craddle was modified to take a smaller tube. This gave a 540 mm weapon which fired a 3310 lb shell to a distance of about 7½ miles. To increase the mobility of each weapon, it was mounted on a modified PzKpfw IV chassis (See also under Panzer).
Reference: G.B.Jarrett, "Achtung Panzer", The Story of German Tanks in WW II, Great Oaks, RD 1, Aberdeen, Md (1948)
Note: According to the "Enemy War Materials Inventory List", Supreme Headquarters Allied Expeditionary Force, April 1945, p 133, the weapon designated Karl Mrs or Karl Gerät was made in two sizes 54 and 61.5 cm.

Thunderit (Thunderite). A permissible explosive manufactured at the beginning of this century at the Schlebusch Fabrik D A -G and introduced into England under the name of **Coalite**. It consisted of Am nitrate 91-93, TNT 3-5, flour 3-5 and moisture 0.5%.
Reference:
J.Daniel, Dictionnaire des Matières Explosives, Dunod, Paris (1902), p 767.

Tiefbonder Verfahren (Deep Bonding Process). This term designated a method of deep surface treatment of sintered metal projectiles developed by Dr V.Duffek and collaborators. The method was claimed to diminish the wear of gun barrels and to increase the effectiveness of armor penetration of these projectiles.

Previous to WW II, the Germans, in some of their rapid-firing guns, used projectiles containing either a lead core or a lead head with a sheath made of cast iron plated with tombak metal (an alloy of Cu and Zn). Beginning about January 1941, when a shortage of lead developed, the Germans tried to use projectiles made entirely of sintered iron. However, the use of these projectiles was not a success because the wear of the bore was so great that after about 400 rounds the gun became unusable. In order to decrease the friction, an attempt was made to zincate the sintered iron projectiles, but this method did not decrease friction sufficiently to effect a noticeable decrease in the wear of the bore.

Knowing that some crystalline inorganic compounds possess the property of showing decreased friction when subjected to high temperatures, high pressures, or to a certain extent to impact stresses, Dr Duffek proposed to cover the sintered metal projectiles with such substances. The surface covering was achieved by the phosphatizing process (used in industry to reduce corrosion), which consisted essentially of a treatment of an iron object with an acidic phosphate solution (Parkerizing). As result of this, a thin layer of crystalline iron phosphate was deposited on the surface of the metal.

Although this method of phosphatizing decreased the friction of projectiles in the bore, the amount of phosphate deposited on the surface was so slight as to be removed by passage of the projectile through the bore. This meant that if the method were to be used for armor-piercing projectiles there would not be enough low-friction surface material left to improve the penetration of armor.

The investigation of Dr Duffek was continued, and on the strength of his suggestions a process was developed by the Metallgesellschaft A -G, Frankfurt a/M (Dr L. Schuster) (Ref 2) which permitted deposition of thicker surface layers of phosphate crystals due to deeper penetration of the phosphate solutions into sintered iron objects.

This process, called Tiefbonder-Verfahren (Deep Bonding Process), may be conducted by one of three methods described in the patent. The following method was recommended by Dr Duffek:

a) Treat the sintered iron article with vapors of trichloroethylene in order to remove any oil or fat from the pores
b) Transfer the article to a bath containing 8 g of NaOH and 2 g $NaNO_2$ per liter and maintained at 95°
c) After remaining there for exactly one minute, remove the article and, without rinsing, place it in a bath consisting of solutions of Zn phosphate and nitrate (containing 5.4 g Zn, 7 g P_2O_5 and 6.9 g NO_3 per liter). The bath is maintained at 95°
d) After keeping in the bath for 5 minutes, remove the article and rinse it thoroughly under cold water
e) Treat the article for one minute at 95° in a bath containing 5 g of a mixture consisting of 30% Na silicate, 45% $NaNO_2$ and 25% NaOH per liter. Then place it for 40-60 seconds in a bath containing a solution of 0.5 g Na chromate per liter of water and maintained at 95°
f) Remove the aritcle and dry it.

It was claimed by Dr Duffek that when sintered iron bullets treated by this method were fired from a pistol (in 1942) there was no noticeable wear of the bore even after 4600 rounds. This was considerably better than with the pre-WW II bullets with a lead core.

On the strength of this success, Dr Duffek was allowed by the German War Ministry (near the end of WW II) to develop a new type of AP (armor-piercing) projectile. After prolonged investigations, the following method was developed:

A sintered iron sheath, consisting of fine grains of iron on the inside layers and coarse grains on the outside sheath, was welded to the surface of an ordinary solid steel projectile. The welding was done by the high-frequency method (Hochfrequenz) developed by the Siemens Co. Then the surface of the shell was

treated by the Deep Bonding Process, as described above.

About 50 projectiles caliber 20 mm, and some 37 mm, were prepared by this method and then tested by firing against a 5 cm thick chromium-nickel steel armor plate placed at a distance of 200 meters. The results showed that the average penetration was about 2/3rd deeper than with an untreated standard AP shell.

References:
1) Dr V.Duffek, Report to the High Command of the German Forces (Document of the Chemisch-technische Reichsanstalt, Berlin) and private communication
2) Metallgesellschaft A-G, Frankfurt a/M, Ger Pat M 153085 VI/48d, Jan 26, 1942.

"Tiger" I, II, etc. Nicknames for a series of heavy tanks. (See under Panzer).

Tilt Type Igniter (Kippzünder). See under Igniter.

Titanium Alloys and their methods of manufacture in Germany are described by L.S.Busch & R.H.Freyer, PB Rept 100,000 (1948-1949). Some of these alloys were used as components of ordnance items.

Titanium Tetrachloride (Titanchlorid), designated as FM, is described in the general section. It was used by the Germans as a smoke producing agent in some hand grenades.
(See also under Smoke Hand Grenade).

T-Mine. See under Landminen.

TNT. See Trinitrotoluol, (Trotyl).

Toluol (Toluene) is described in the general section. The manufacture of toluene in Germany was discussed by W.F. Faragher and W.A. Horne, U S Bur Mines Inform Circ 7376 (1946). The authors interrogated Dr Pier and the staff of I G Farbenindustrie, A G, Ludwigshafen and Oppau [C A 41, 5234 (1947)].

Note: According to H. Walter et al, PB Rept 78,271 (1947), The Germans developed a method for the manufacture of toluene by the interaction of benzene and methanol in the presence of phosphoric acid. The method is not described.

The German nitration grade toluene obtained from the coal tar industry contained 0.7 - 0.8% paraffins, while synthetic toluene contained about 0.5%.

p-Toluolsulfamid (p-Toluenesulfamide). See Plastol. It was found to be a suitable plasticizer for collodion cotton.

p-Toluolsulfosäureäthylester (p-Toluenesulfonic Acid Ethyl Ester). See Mittel AEP.

Tonka. A liquid rocket fuel developed in Germany during WW II. It was a mixture of aniline, monoethylaniline, dimethylaniline, gasoline, napcha, triethylamine, and isohexylamine and was used in conjunction with nitric acid to propel the air-to-air guided missile called Ruhrstahl X-4 (Refs 1 & 2).

According to Ref 3, the so-called Tonka 250 consisted of crude m-xylidine 57 and triethylamine 43%. It was used in conjunction with strong (98-100%) nitric acid (Salbei) serving as a source of oxygen.

References:
1) H.Gartmann, Weltraumfahrt No 6, p 134 (1951), Jato and Auxiliary Rocket Power Plants, C A 46, 4233 (1952)
2) K.W.Gatland, Development of the Guided Missile, Philosophical Library, N Y (1952), p 123
3) TM 9-1985-2 (1953), p 216.

Topfmine A (Pot-Shaped A/T Land mine). It is described on p 271 of TM 9-1985-2 (1953). See also under Landminen.

Topf Zünder. Pressure type igniter designed for use with the Topfmine [TM 9-1985-2 (1953), p 306].

Torpedo, Ein Man (One Man Torpedo). See U-Boat, One Man.

Totalit (Totalite). Totalites are military explosives consisting of ammonium nitrate blended with paraffin. These mixtures were the most inert and the least sensitive of all the military explosives used. Instead of paraffin, waste oils or naphthalene were tried. Stettbacher tried to use Totalit in conjunction with thermite priming (Thermitzündung) but could not get good results. This was due to the fact that only at lower densities, such as 1.25, did the Totalit detonate completely, while at higher ones, such as 1.5 or 1.6, the detonation was not complete.

Stettbacher (Ref 1) gives the following properties for the Totalit containing 5.47% of paraffin:

vol of gases at NTP 971.5 l/kg, heat of explosion at C_v water vapor 1162 kcal/kg and with water liquid 1438 kcal/kg, temp of explosion 3105°, specific pressure (f) 12,021, brisance value (B) by Kast 49.7×10^6, veloc of deton 2500 m/sec at d 1.60.

Note: Definitions of values (B) and (f) are given in the general section.

References:
1) A.Stettbacher, Nitrocellulose 10, 109-10 (1939)
2) A.Stettbacher, Spreng- und Schiesstoffe (1948), p 106.

Tot-Kühlung (Dead-Cooling). See general section.

Tot-pressung (Dead-Pressing). See general section.

Tötungskoeffizient (Killing or Destruction Coefficient). It is the ability of a unit weight of an explosive to inflict casualties or to cause destruction as compared with a unit weight of a standard explosive, such as TNT [A.Stettbacher, Spreng- und Schiesstoffe (1948), p 155].

Tracer Compositions (Leuchtspursätze oder Lichtspursätze). Compositions used by the Germans during WW I were described by Langhans (Ref 1), while some of those used during WW II were described in the book in Italian by Izzo (Ref 5) and in some Picatinny Arsenal Technical Reports (Refs 2, 3). PB Report 11 544, listed as Ref 4, is the condensation of some Picatinny Arsenal Reports.

The following German compositions, used in tracer ammunition, are described in the book of Izzo:

a) Ignition mixture: Zr 13, K nitrate 12 and black powder 75%

b) Intermediate mixture: Al 15.1, Ba nitrate 29.5, K nitrate 12.0, sulfur 6.0 and black powder 37.4%

c) Illuminating mixture (tracer): Mg 40.5, Na nitrate 54.5 and wax (synthetic, type L) 5.0%

d) Ignition mixture: Zr 52 and K nitrate 48%

e) Intermediate mixture: Ba peroxide 80 and Al 20%

f) Illuminating mixture (tracer): Ba nitrate 74 and Al 26%.

The following tracer and tracer igniter compositions, manufactured by the Deutsche Waffen- und Munitionsfabriken A-G, Lübeck, are described by H.Peploe et al (Ref 6):

g) Day tracer for the 7.92 mm bullet SmKL: Mg powder 32.5, Ba nitrate 45.5, Na carbonate (anhydrous) 12.0

Table 41 (Tracers and Igniters for Tracers)

Item	Composition %: Magnesium	Ba peroxide	Ba nitrate	Ba carbonate	Sr nitrate	Sr picrate	Na oxalate	K nitrate	Phenolic resin	Phenol-formaldehyde resin	Binder & fuel	Resin	Nitrocellulose	Other ingredients		Used in
Dark Ignition	2.7	0.8	-	-	-	-	-	50.0	-	10.6	-	-	-	Sulfur Carbon Sb sulfide	6.1 15.9 13.9	7.92 mm APHV
Primer	30.0	39.6	-	-	-	14.2	6.8	-	-	9.4	-	-	-	-	-	Same as above
Tracer	30.9	-	29.5	-	10.3	-	12.6	-	-	12.4	-	-	-	Unac	4.3	Same as above
Igniter pad	-	-	-	-	-	-	-	-	-	-	-	-	100% (col)	-	-	7.92/13 mm
Igniter	36.0	-	19.2	-	-	-	-	-	-	-	18.8	-	-	Styphnic acid and binder	26.0	Same as above
Tracer	35.9	-	36.9	-	-	-	-	15.2	-	-	10.5	-	-	Sulfur	1.5	Same as above
Igniter	24.1	75.6	-	-	-	-	-	-	-	-	2.3	-	-	-	-	20 mm AP (Inert charge)
Tracer	40.5	-	28.0	-	-	-	-	-	-	-	14.9	-	-	Ba oxalate	16.2	Same as above
Igniter pad	-	-	-	-	-	-	-	-	-	-	-	-	100% (col)	-	-	20 mm APHV
Igniter	36.7	-	32.7	-	-	-	-	-	-	-	18.7	-	-	Na picrate	11.9	Same as above
Tracer	33.2	-	-	-	39.7	-	17.0	-	-	-	10.1*	-	-	-	-	Same as above
Igniter	19.1	78.4	-	-	-	-	-	-	-	-	2.5	-	-	-	-	20 mm HE SD
Tracer	18.2	-	51.4	-	-	-	-	-	-	-	-	22.2	-	Aluminum	8.2	Same as above
Igniter	22.8	62.6	-	14.6	-	-	-	-	-	-	-	-	-	-	-	20 mm Inc
Tracer	33.9	-	18.1	-	-	-	-	10.1	-	-	8.2	-	-	Ba oxalate	29.7	Same as above
Igniter	22.0	-	75.0	-	-	-	-	-	-	-	3.0	-	-	-	-	37 mm APHV
Tracer	28.5	-	50.0	-	-	-	11.2	-	-	10.3*	-	-	-	-	-	Same as above
Igniter pad	-	-	-	-	-	-	-	-	-	-	-	-	75.0	DEGDN	25.0	37 mm HE
Igniter	30.0	-	36.0	-	-	11.0	-	-	-	-	23.0	-	-	-	-	Same as above
Tracer	43.1	-	40.9	-	-	-	12.0	-	-	-	-	-	-	Sulfur Unac	2.2 1.8	Same as above
Igniter	27.0	-	42.0	-	3.0	-	-	-	28.0	-	-	-	-	-	-	37 mm HE
Tracer	32.0	-	36.0	11.0	-	-	12.0	-	-	-	-	-	-	Mg hydroxide Wax Unac	6.0 2.0 1.0	Same as above
Igniter pad	-	-	-	-	-	-	-	-	-	-	-	-	100% (col)	-	-	37 mm HE
Igniter	30.0	-	36.0	-	-	11.0	-	-	-	-	23.0	-	-	-	-	Same as above
Tracer	43.1		40.9	-	-	-	12.0	-	-	-	-	-	-	Sulfur Unac	2.2 1.8	Same as above
Igniter	16.6	66.1	-	-	-	-	-	-	-	-	3.5	-	-	Red lead (Pb_3O_4)	13.8	37 mm APMB & APRN
Tracer	34.0	-	60.0	-	-	-	-	-	-	-	6.0*	-	-	-	-	Same as above

Table 61 (cont'd)

Tracer	31.2	-	13.2	-	50.8	-	-	-	-	-	-	4.8	-	-	-	40 mm HE Bofors
Igniter pad	-	-	-	-	-	-	-	-	-	-	-	-	75.0	DEGDN	15.0	47 mm APHV, Needlepoint
Igniter	15.5	-	41.7	-	-	-	30.0	-	-	-	12.8	-	-	-	-	Same as above
Tracer	25.0	-	64.0	-	-	-	5.5	-	-	-	5.5	-	-	-	-	Same as above
Igniter	21.4	76.4	-	-	-	-	-	-	-	-	2.2	-	-	-	-	47 mm AP RN
Tracer	58.2	-	-	-	37.6	-	-	-	-	-	4.2	-	-	-	-	Same as above
Igniter pad	-	-	-	-	-	-	-	-	-	-	-	-	75.0	DEGDN	25.0	50 mm APHV SC
Igniter	15.5	-	41.7	-	-	-	30.0	-	-	-	12.8	-	-	-	-	Same as above
Tracer	25.0	-	64.0	-	-	-	5.5	-	-	-	5.5	-	-	-	-	Same as above
Igniter	20.2	79.8	-	-	-	-	-	-	-	-	-	-	-	-	-	50 mm APC SC and APC LC
Tracer	31.5	-	62.6	-	-	-	-	-	-	-	4.1	-	-	Aluminum	1.8	Same as above
Igniter	30.0	-	41.7	-	12.8	-	-	-	-	-	15.5	-	-	-	-	50 mm APHV SC
Tracer	25.0	-	64.0	-	-	-	5.5	-	-	-	5.5*	-	-	-	-	Same as above
Igniter	17.9	64.8	-	17.3	-	-	-	-	-	-	-	-	-	-	-	75 mm AP
Tracer	32.9	-	62.0	-	-	-	-	-	-	-	5.1	-	-	-	-	Same as above
Igniter	14.2	69.7	-	15.5	-	-	-	-	-	-	2.6	-	-	-	-	88 mm AP
Tracer	35.4	-	-	-	56.9	-	-	-	-	-	7.7*	-	-	-	-	Same as above
Igniter	19.6	78.0	-	-	-	-	-	-	-	-	2.4	-	-	-	-	88 mm AP
Tracer	20.8	-	76.5	-	-	-	-	-	-	-	2.7	-	-	-	-	Same as above

* The binder in the above tracers was identified as an "A" stage phenolformaldehyde condensation product. It seems that this type of binder was used in many German tracer compositions.

Abbreviations: AP Armor-piercing; APC Armor-piercing, capped; C Capped, Case, or celloided; Ct Cartridge; DEGDN Diethyleneglycoldinitrate; HV Hyper velocity; Inc Incendiary; LC Long case; LCt Long cartridge; MB Monoblock; SC Short case; SCt Short cartridge; SD Self-destroying; Unac Unaccounted.

Notes:

a) In the majority of German weapons ranging from 15 mm to 88 mm, igniter compositions for tracers (ICT) consisted of a peroxide, metallic Mg and a binder. These compositions were similar to the U S Standard Igniter Composition "K". Some German ICT's contained metallic picrates or styphnic acid in addition to Ba nitrate, metallic Mg and a binder

b) A majority of tracer compositions (TC) found in German (as well as in most other foreign ammunition) consisted principally of Ba nitrate, metallic Mg and a binder. These compositions produced white light upon burning. Only two red light TC (tracer compositions) were found. They consisted of Sr nitrate, metallic Mg and a binder. The TC which contained Na oxalate in addition to Sr nitrate, Mg and a binder, burned with a yellow light

c) Since TC containing Ba nitrate burned slower than those containing Ba peroxide, it appears that picrates or styphnic acid may have been added to increase the burning rate. Due to the fact that picrates and styphnic acid contain oxidizing radicals, it is possible that the addition of such materials by the Germans caused the igniter compositions to have lower ignition temperatures and more uniform burning characteristics. Similar effects have been observed at Picatinny Arsenal when nitroindene polymer (q v) was substituted for charcoal in fuze powders.

References: (Tracer Compositions):
1) A.Langhans, S S 17, pp 34, 43, 61, 68, 77, 90 and 105 (1922)
2) Picatinny Arsenal Tech Rept 1335 (1943)
3) Ibid 1555 (1945)
4) PB Rept 11 544 (1945)
5) A.Izzo, Pirotecnia e Fuochi Artificiali, Hoepli, Milano (1950), pp 205-6 and 220-1
6) H.Peploe et al, CIOS Report 33-20 (1945), pp 24-5 & 78-9.

and Ersatz resin (phenolformaldehyde base) 10.0%

Note: The trace was yellow. For a white trace the Na carbonate was omitted and the amount of Ba nitrate correspondingly increased. The tracing length was 900 meters.

h) Tracer priming composition for the above bullet: Ba nitrate 64.5, Sr peroxide 5.5, red lead 10.5, Mg powder 15.5 and shellac 4.0%

i) Night tracer for the above bullet: Ba peroxide 53.0, Ba sulfate 22.0, Sr peroxide 7.5, K nitrate 7.5 and Ersatz resin 10.0%

Note: The Ba sulfate was used to keep the temperature down. The tracing length was 600 meters.

j) Tracer priming composition for the above bullet: Ba peroxide 81.0, Sr peroxide 3.0, Sr oxalate 3.0, Ca silicide 9.0 and Ersatz resin 4.0%

k) Red tracer for SmKL bullet: Sr nitrate 42.5, Sr peroxide 17.5, Mg 27.0, Fe lactate 3.8 and pine resin 9.2%

Note: The weight of the tracer was 0.3 g and the tracing length 500 yds.

l) Green tracer for the above bullet: Mg 25.0, Ba nitrate 65.0 and shellac or pine resin 10.0%

Note: The weight of the tracer was 0.22 g and the tracing length 500 yds.

m) Red tracer for 20 mm AA guns: Sr nitrate 57, Mg 19, Na carbonate (anhydrous) 8, Sr fluoride 5, Mg stearate 1 and phenol formaldehyde 10%

n) Yellow tracer for 20 mm AC guns: Ba nitrate 57, Mg 19, Na carbonate (anhydrous) 8, Sr fluoride 5, Mg stearate 1 and phenol formaldehyde 10%

o) Yellow tracer for 20 mm AP ammunition: dextrine 6.5, phenol formaldehyde 10.0, polyvinyl chloride 1.0, Ba nitrate 53.0, Mg 24.5 and Sr flouride 5.0%

p) Red tracer for 20 mm AP ammunition: Sr nitrate 53.0, Mg 24.5, Sr fluoride 5.0, dextrine 6.5, phenol formaldehyde 10.0 and polyvinyl chloride 1.0%

r) Night tracer for 20 mm ammunition: Ba peroxide 53.0, Ba sulfate 22.0, Sr peroxide 7.5, K nitrate 7.5 and phenol formaldehyde 10.0%. Used without priming

Note: Could be used in 7.92 mm ammunition in conjunction with dim priming composition described below:

s) Dim priming composition contained: Ba peroxide 81, Sr peroxide 3, Sr oxalate 3, Mg (fine powder) 9 and phenol formaldehyde 4%

t) Bright priming composition: Ba peroxide 63.82, Sr peroxide 5.32, lead oxide (Pb_3O_4) 10.62, Mg (powder) 15.98 and shellac 4.26%

u) Dark ignition priming: Ba peroxide 81, Sr peroxide 3, Sr oxalate 3, Ca silicide 9 and phenol formaldehyde 4%.

Table 61 gives the composition of tracers and their igniters as determined during WW II at Picatinny Arsenal. (See following pages).

References: See under Table 61.

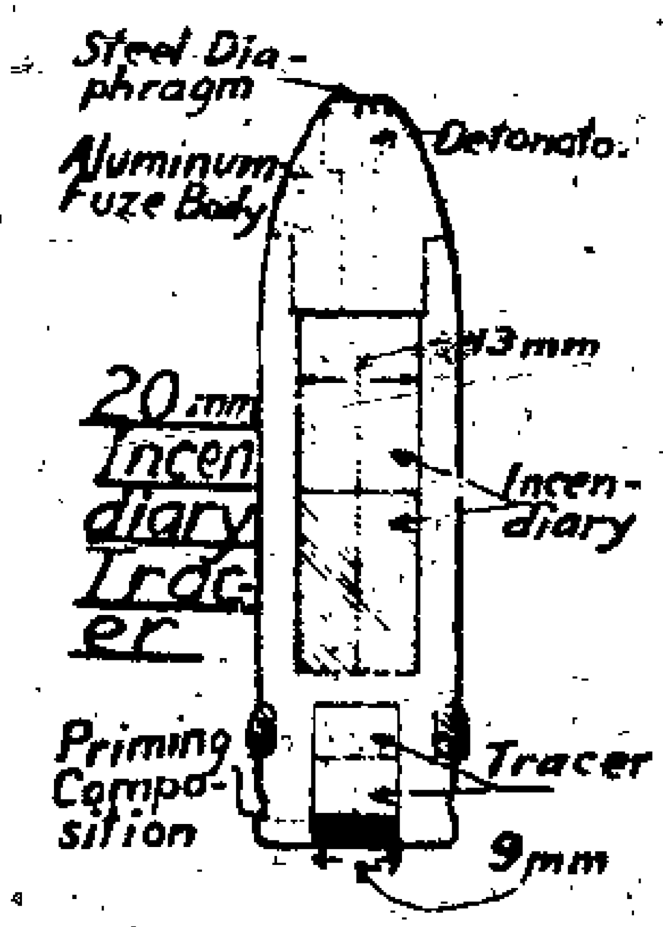
Tracer Projectiles. Many German projectiles were provided with tracers. Following are some tracer projectiles described in Refs 1 & 2:

a) 20 mm Incendiary - Tracer, Proj (Ref 1, p 64)
b) 20 mm Incendiary - Tracer, Self-Destroying Proj, (Ref 1, p 56) (See Illustration under Self-Destroying Proj)
c) 20 mm APHE - Tracer, Self-Destroying Proj (Ref 1, p 59) (See illustration under Self-Destroying Proj)
d) 37 mm Projectiles: AP, Arrowhead with Tungsten Carbide Core, AP Without Cap for A/T and AA Guns, HE for A/T and C/30 Guns (Ref 2, pp 373, 382, 384, 387 and 388) (See Illustration)
e) 40 mm HE Proj for AA Gun (Ref 2, p 389)
f) 42-28 mm AP Proj with Core, for Tapered-Bore Gun (Ref 2, p 375) (See illustration under Tapered Bore Gun)
g) 47 mm AP, Arrowhead Proj with Tungsten Carbide Core (Ref 2, p 376)
h) 50 mm and 75 mm Arrowhead Proj with Tungsten Carbide Core (Ref 2, pp 377-8) (See illustration under Arrowhead Projectile)
i) 75 mm AP Projectiles (Ref 2, pp 408, 410, 423 & 424
j) 76.2 mm Russian Design Projectiles (Ref 2, pp 428, 429 & 431)
k) 88 mm AP Projectiles (Ref 2, pp 437, 439-441, 443-4 & 446/8)
l) 105 mm AP Projectiles (Ref 2, pp 456, 458-9 & 469) (See illustration)
m) 128 mm AP Projectiles (Ref 2, pp 384-4)
n) 150 mm HoC Proj for Howitzer (Ref 2, p 487)
o) 194 mm French Design HE Proj for Railway Gun (Ref 2, p 517)
p) 203 mm HE Proj for Railway Gun (Ref 2, p 521)
r) 240 mm HE Proj for Theodor Bruno Railway Gun (Ref 2, p 524)
s) 280 mm HE Proj for Railway Gun (Ref 2, p 528)
t) 353 mm Anticoncrete Proj for Howitzer MI (Ref 2, p 529).

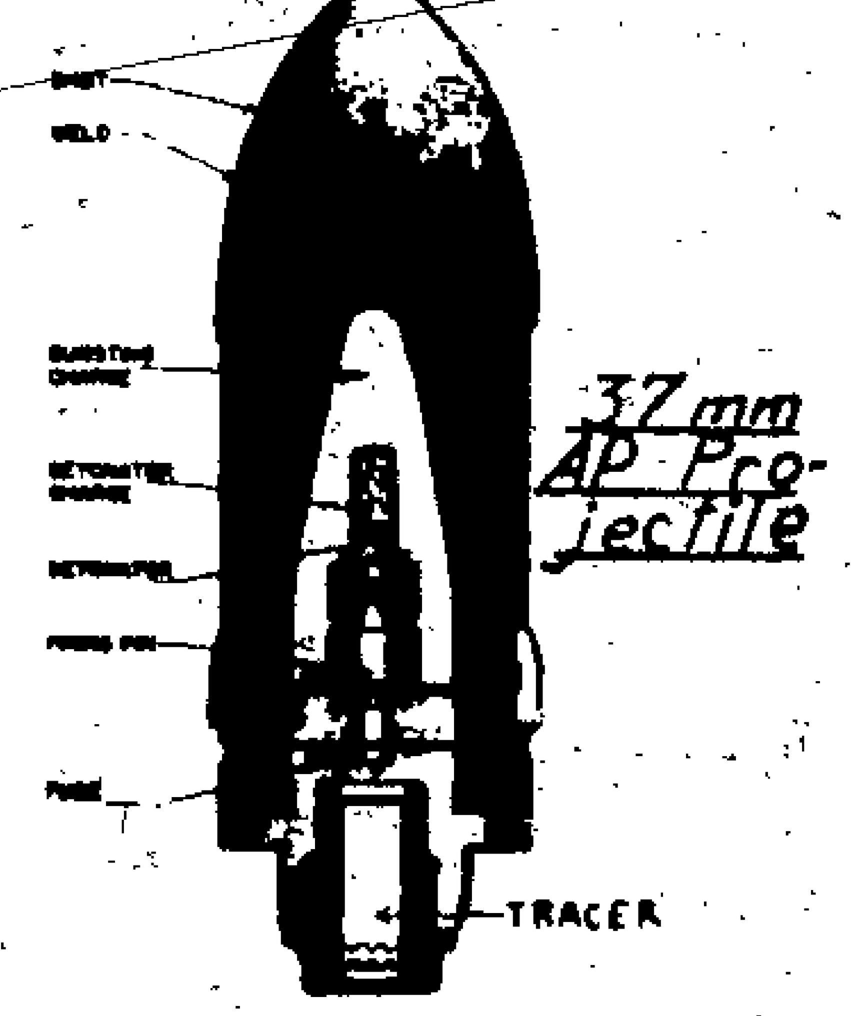
(See also illustrations under Granate).

Abbreviations: AA Antiaircraft; AP Armor-Piercing; A/T Antitank; C Capped; HE High Explosive; HoC Hollow charge (shaped charge)

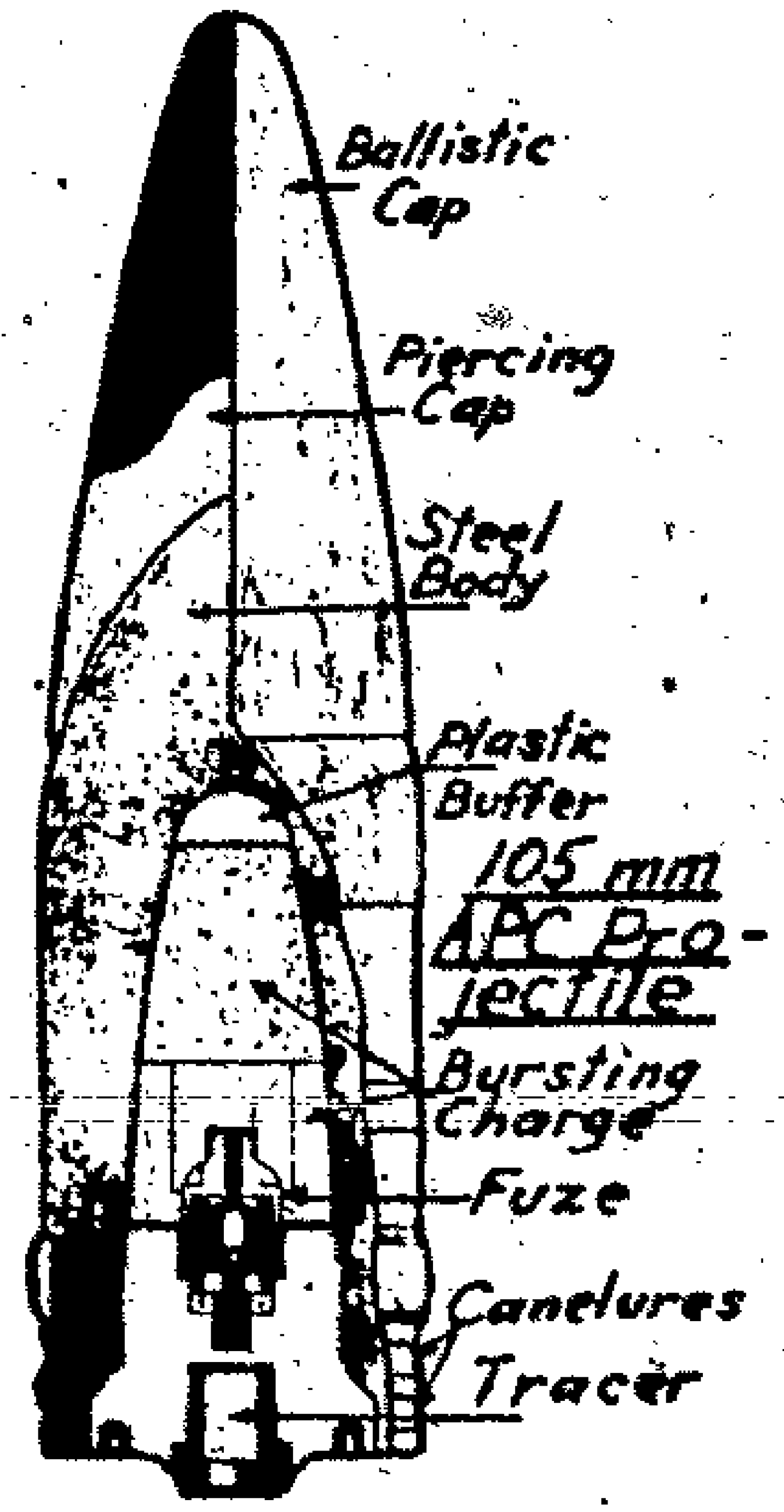
References:
1) H.Peploe et al, CIOS Rept 33-20 (1945)
2) Anon, TM 9-1985-3 (1953).



20 mm Incendiary Tracer



37 mm AP Projectile



Trauzl Dynamite or Guncotton Dynamite. One of the earliest dynamites with an active base. It was prepared by Trauzl in 1867 by impregnating a mixture of guncotton 25 and charcoal 2 parts with nitroglycerin 73 p in the presence of 15 p added moisture. It was handled in the moist state, and in this condition it could be detonated with a strong blasting cap. It propagated detonation completely. A similar explosive called Glyoxilin was invented in 1867 by the British scientist F.Abel.

References:

1) J.Daniel, Dictionnaire des Matières Explosives, Dunod, Paris (1902), p 772

2) P.Naoum, Nitroglycerin, Williams and Wilkins, Baltimore (1928), p 282.

Trauzlsche Probe (Trauzl Test) oder Bleiblockausbauchungs Probe (Lead Block Expansion Test). See Trauzl Test in the general section.

Treibpulver oder Treibmittel. See Propellant.

Treibsätze (Propellent Substitutes). The following substances, described separately elsewhere, were developed as possible substitutes for black powder and smokeless propellants:

a) Gelbmehl (Tetranitrocarbazole)
b) Gelbmehl S (Tetranitrodiphenylsulfone)
c) GP (Powder) and
d) Trinitro - *N* - ethylaniline.

Reference: CIOS Report 25-18 (1945), pp 27-28.

Treibspiegelgeschoss. See Sabot Projectile.

Tremonit SII (Tremonite SII). One of the permissible explosives used before and after WW I: dinitroglycerin 33, collod cotton 1, meal 12, TNT 2.5, Am nitrate 26.5 and Na chloride 25.0%.

Reference: E.Barnett, Explosives, N Y, (1919), p 139.

Trench Mortar Bomb Explosive of WW I. According to Davis (1943) p 391, the following composition was used: NGu 50, Am nitrate 30 and paraffin 20%.

Tri. Abbreviation for Trinitrotoluene (TNT), also called Trotyl.

Trialen oder Tetronal. An underwater explosive consisting of RDX, TNT and Al powder. It was similar to Torpex described in the general section. At least four varieties of Trialens are known: Trialen 105, Trialen 106, Trialen 107, and Trialen 109 (See Fillers 105, 106, 107 & 109). One of the Trialens was used for filling the V-2 rocket warheads. (See also under Unterwassersprengstoffe).

Tricinat oder Trizinat. See Bleitrinitroresorcinat.

Triethylenglycoldinitrate: See Triglykoldinitrat.

Triglykoldinitrat (Triethyleneglycoldinitrate) (TEGDN). See also in the general section. It was proposed by General Gallwitz for use as a gelatinizer in cool double-base propellant (G-pulver) destined for tropical climates, such as Africa. Although TEGDN is much less volatile than DEGDN it is more volatile than NG (about 1.5 times). It has good chemical stability and is a good gelatinizer. Its calorific value Q is 750 kcal/kg, with H_2O liquid. It is obtained by the nitration of triethyleneglycol (TEG), a by-product of the manufacture of diethyleneglycol (DEG). The highest yield of TEG is below 20%, the rest being DEG. For safety reasons the spent acid must be drowned, which makes the process rather uneconomical.

Following is a brief description of the nitration as practiced at the Krümmel Fabrik, D A -G:

500 kg of tech TEG (which usually contained some DEG) was run slowly into mixed acid consisting of 70% nitric and 30% sulfuric acids, stirred and maintained at 25°C. After 30 minutes of nitration the mixture was drowned (see Note) in a large volume of cold water. The separated oil (TEGDN) was washed twice with cold water, once with dilute soda ash solution, and finally again with water. The yield was 650 kg, or 130% of TEG.

Note: As the mixture obtained on nitration of TEG is extremely unstable it was not allowed to stand to effect the separation of oil (TEGDN) from the spent acid, as is the general practice with other nitrated glycols, glycerin, etc. Another reason why the mixture was drowned is explained by the high solubility of TEGDN (8 9%) in undiluted spent acid and comparatively low solubility in an acid diluted by water.

Following were the properties of technical TEGDN: N=12.1 to 12.2%, vs theoretical 11.67% (see Note below), color-brownish, d=1.335, thermal stability-satisfactory (the 82° KI test gave 20 minutes), impact sensitivity-could not be exploded by the impact of 2 kg weight.

Note: The high N content of tech TEGDN may be due to the presence of as much as 21% of DEGDN.

Reference: O.W.Stickland, PB Rept 925 (1945), pp 13 & 60.

Trilons are extremely toxic products discovered before WW II in Switzerland and in Germany during research studies on insecticides derived from phosphoric acid. Dr Wirth of Berlin studied the toxic properties of these compounds with a view to their military application and recommended some of them to the German Government.

About two hundred toxic derivatives were prepared in the laboratories of I G Farbenindustrie at Ludwigshafen but only the following three were considered suitable for military applications.

a) **Tabun** (Trilon 83 or T 83, also called T 100) was the **monoethyl ester of dimethylaminocyanophosphoric acid**,

$$(CH_3)_2N-\overset{\overset{O}{\|}}{\underset{\underset{CN}{|}}{P}}-OC_2H_5$$

It was prepd by treating the dichloride of dimethylaminophosphoric acid (an irritating agent called Product 39) with Na cyanide, ethanol and chlorobenzene. Technical Tabun was a dark brown oil with a fishy odor and d 1.077 at 20°. In the pure state it was colorless.

Tabun was planned to be used in chemical bombs and rockets. Initially the Tabun used in munitions contained 5% chlorobenzene (Tabun A) but, to render this product more stable and to lower its vapor tension, the amount of chlorobenzene was increased to 20% (Tabun B).

Note: This compound is called by H.A.Curtis, CIOS Report 28-62 (1945), p 24, Torbun or Trilon 83.

b) **Sarin** (Trilon 46 or T 46, also called T 114) was the **monoisopropyl ester of methylfluorophosphoric acid**,

$$CH_3-\overset{\overset{O}{\|}}{\underset{\underset{F}{|}}{P}}-O-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{CH}}$$

It was prepared either by the salt process or by the rearrangement process mentioned but not described by Collomp. Sarin was a colorless, odorless and very volatile liquid about 3 times as toxic as Tabun.

Due to the fact that Sarin was more toxic and more resistant to heat than Tabun, it was planned to use it in munitions in preference to Tabun.

According to McLeod (Ref 2), Sarin was invented by G.Schräder and is called the "nerve gas".

c) **Soman** (Trilon?) was the **monopinacolic ester of methylfluorophosphoric acid**,

$$CH_3-\overset{\overset{O}{\|}}{\underset{\underset{F}{|}}{P}}-O-\overset{\overset{CH_3}{|}}{\underset{\underset{C(CH_3)_3}{|}}{CH}}$$

It was prepd according to Collomp in a manner similar to Sarin.

Soman was a colorless liquid having an odor of camphor. It was less volatile than Sarin but even more toxic.

Production of Trilons started about 1940 in a specially constructed factory at Dyhernfurth-an-der Oder, 40 km from Breslau. The factory was never discovered by the Allies and is now in the hands of the Russians.

References:

1) Capt Collomp, Revue Manuel de L'Armée de l'Air No 37, October, 1949

2) R.D.McLeod, Chem Engrg News 32, 8 (1954).

Trimethylaminoxide Nitrate, $(CH_3)_3N:(OH)(O.NO_2)$. This compound was prepd by Walter et al by treating trimethylaminoxide, $(CH_3)_3NO$, which is a base, with nitric acid. The trimethylaminooxide was prepd by the oxidation of trimethylamine, $(CH_3)_3N$.

Trimethylaminooxide nitrate proved to be of low thermal stability and was considered unsuitable for use in military explosives.

Reference:

H.Walter et al, German Developments in High Explosives, PB Rept 78,271 (1947), p 8.

Trimethylammonium Nitrate, called by the Germans Tri-Salz is described in the general section.

Trinol. One of the names for Trinitronaphthalene.

2,4,6-Trinitramine-1,3,5,7-tetramethylene-1,7-dinitrate, $(O_2NO)CH_2\cdot N(NO_2)CH_2\cdot N(NO_2)CH_2\cdot N(NO_2)CH_2(ONO_2)$, mp 155°; was obtained during WW II as a by-product of the manufacture of RDX, using either the E-Salz or the K-Salz process. These processes are described in this section under Hexogen.

The power of trinitraminotetramethylene dinitrate as determined by the Trauzl Test was claimed to be higher than for RDX.

Reference: G. Römer PBL Rept 85,160 (1946), p 16.

Trinitroanisol oder Trisol (Trinitroanisole) (TNAns). See general section under Anisole. TNAns was used in Germany during WW I as a filler for long range projectiles (Ferngeschützgranaten) fired against Paris and also in some bombs.

(See also Dinitroanisol).

Reference: A. Stettbacher, Spreng- und Schiesstoffe, Zürich (1948), p 77.

Trinitrobenzol (Trinitrobenzene) (TNB). See general section under Benzene. TNB was used in Germany as a military explosive under the name of Filler 70.

Reference: Allied and Enemy Explosives, Aberdeen Proving Ground (1946), p 112.

Trinitrochlorbenzol (Trinitrochlorobenzene) (TNCB). See general section under Chlorobenzene. The compressed TNCB was used by the Germans during WW II under the name of Filler 60 and was cast under the name of Filler 61. TNCB was also used in admixture with Am nitrate under the name of Filler 64.

Reference: Allied and Enemy Explosives, Aberdeen Proving Ground (1946), p 113.

Trinitrodichlorbenzol (Trinitrodichlorobenzene) (TNDCB). See general section under Dichlorobenzene. TNDCB was used in Germany as an explosive and also as an insecticide.

Reference: PB Rept 1820 (1945), p.10.

Trinitro - N - ethylaniline is described in the general section under Ethylaniline. It was investigated during WW II as a possible substitute for black powder and smokeless propellants especially for use in mortars and Faustpatrone. The development was stopped due to the unfavorable raw material situation (See also under Treibsätze).

Reference: CIOS Rept 25-18 (1945), p 28.

Trinitronaphthalin (Trinitronaphthalene) (TNN), and **Dinitronaphthalin** (Dinitronaphthalene) (DNN) were used by the Germans during WW II in some composite explosives. They were manufactured at Semitin Fabrik, Pardubice, Czecho-Slovakia. See also general section under Napthalene.

Trinitroresorcin (Trinitroresorcinol) (TNR), or, Styphnic Acid. See Trizin.

TRINITROTOLUOL oder TROTYL (Trinitrotoluene) (TNT) (Füllpulver 02 oder Fp 02 (Filler 1902). $CH_3\text{-}C_6H_2(NO_2)_3$. It is described more fully in the general section under Toluene.

TNT was officially adopted in Germany in 1902 as a military explosive, earlier than in any other country. Its actual use by the Army was begun in 1904, and the industrial production started in 1906 at the Schlebusch Fabrik, D A -G.

For the description of German methods of preparation of TNT, as practiced before, during and after WW I, see the books of Escales (Ref 1) and Stettbacher (Ref 2). The same books give also the properties of TNT.

It is to be noted that before and during WW I the Germans used a rather complicated process for the manufacture of TNT. This was due to the fact that toluene in those days was rather impure. This method, described by Escales (Ref 1, p 137) was briefly as follows:

After nitrating toluene by means of weak mixed nitric-sulfuric acid to produce MNT (mononitrotoluene), the crude product (mono-oil) was separated from the mono-spent acid, then washed with water and finally with weak soda-ash solution. After blowing live steam through the oil (in order to remove the benzene present as an impurity as well as any unnitrated toluene), it was cooled to allow the p-MNT to crystallize (m p 51.9°C). After separating the p-MNT by filtration, the remaining liquid fraction was subjected to fractional distillation under vacuum using a column apparatus. The o-MNT came off first, leaving the m-MNT as a residue. Only p- and o-MNTs were used for the prepn of military grade TNT. The m-MNT was used for the prepn of liquid DNT-TNT mixture (Drip oil) useful as an ingredient of commercial explosives. Another method was to distil the o-MNT from the washed mono-oil and then to cool the residue in order to separate the p-MNT from m-MNT.

The method of purification of TNT proposed by the Chemische Fabrik Grünau was described in Ger P 207-170 (1908).

During WW II the German capacity was as much as 55 million pounds of TNT per month, but the maximum they ever produced was 49.5 million in April 1944. The TNT used by the German Army had a m p of 80.4-80.5°.

The manufacture of TNT during WW II in various German plants is described by Stickland et al (Ref 3 and 4) and Brooks (Ref 6, pp 38-41). It seems that none of the processes used in Germany was as efficient (from the point of view of speed of manufacture and yields) as the process introduced during WW II into this country at Keystone Ordnance Works, Meadville, Penna, by Dr L.A.Gangeroff, and finally adopted by all U S Ordnance plants. The maximum German yield was about 200 parts of TNT per 100 pts of toluene, while the American yield was as high as 210 pts (average yield was 205-208 pts).

In one of the largest German plants, the Krümmel Fabrik of D A -G, the following batch method was used during WW II:

A) **Mononitration** consisted of the following steps:

a) **Pre-nitration.** The mononmixed acid (consisting of 28% HNO_3, 56% H_2SO_4 and 16% H_2O) was added to the charge of toluene in the nitrator 2.5 parts of acid to 1 part of toluene. The temperature was maintained at 35-40° by cooling coils and a jacket

b) **Post-nitration.** The mixture was transferred to a post nitrator where it remained for several hours at 35-40°. Total time required for a full charge of MNT (5 tons) was 5-6 hours

c) **Separation.** The mixture was transferred to a cast iron vessel where it was allowed to stand for 6 hours. The waste acid (N_2O_3 0.5%, H_2SO_4 70% and a small amount of nitric acid) was separated and went to the acid recovery plant while the oil underwent purification

d) **Purification.** The crude oil was washed with water until nearly neutral and was then steam distilled in the presence of NaOH (1% NaOH based on the total weight of MNT). The purpose of adding NaOH was not only to neutralize the remaining traces of acidity but also to transform the nitrocresols, present as impurities, into sodium nitrocresolates, which are soluble in water). During the distillation the first fractions were collected separately because they contained some unnitrated toluene, benzene, and other volatiles. After separating the MNT from the water-soluble fractions, it went through caustic soda washes where the last traces of nitrated cresols were converted to nitrocresolates. The damp neutral MNT (yield 138-144%) was forced by compressed air into a storage tank to be ready for dinitration.

The product separated from impurities consisted of 96% o- and p-MNT and 4% of m-MNT. The purification procedure took about 2 hours. Total time for the preparation of the MNT was 13-14 hours, which was much longer than the present American practice.

B) **Binitration or Dinitration** consisted of the following steps:

a) **Pre-nitration.** A charge of MNT was mixed with bi-spent acid (previously diluted slightly with water to separate the greater part of dissolved DNT) in order to use up any residual HNO_3 as well as to extract the last traces of DNT

b) **Nitration.** After separation from the dilute acid, the oil was fed into the dinitrator containing the tri-spent acid, consisting of 4-5% HNO_3, 3-4% N_2O_3 and 80% H_2SO_4, and cooled to 30°. During the addition of the MNT the temperature rose to 60-65° and then fell to 55° due to the excess of unnitrated MNT

c) **Post-nitration.** In order to complete the dinitration, 60-70% nitric acid was added to the above mixture and the temperature was allowed to rise to 70-72°.

Note: Time required for total dinitration was not given. In order to ascertain if the nitration was completed, a sample of di-oil was taken and distilled with steam. If no MNT distilled off, the nitration was considered complete.

d) **Separation.** After allowing the charge to stand for 1 hour, the oil was separated and transferred to an intermediate storage vessel, while the di-spent acid (ca 5% N_2O_3, 0.6% HNO_3, 78-80% H_2SO_4) was slightly diluted with water in order to separate the greater part of the DNT and to obtain an acid containing about 4.5% N_2O_3, 0.5% HNO_3 and 73% H_2SO_4. This diluted acid was mixed with MNT, as was mentioned under (a). After this, it was transferred to a storage tank where it was allowed to remain for 4-5 days before being sent to the acid recovery plant. Some additional oil separated out during the storage.

Note: Distillation in the recovery house of the di-waste, as well as of the mono-waste acids mentioned previously, gave weak nitric acid (50-55% HNO_3) and weak sulfuric (68-70% H_2SO_4).

C) **Trinitration.** In the older Krümmel plant, the acid was added to the oil while in the newer plant the reverse procedure was used which is the current American practice. The new method was essentially as follows:

a) **Nitration.** The trinitrator was charged with tri-mixed acid (HNO_3 24%, H_2SO_4 78%) at a temp of 74-78° and the di-oil was added gradually, with agitation, while the temp was allowed to rise to 84-85°. The reaction was completed by raising the temp to 96° and maintaining it there for about 4 hours. Total time of nitration was about 6 hours

b) **Separation.** The agitation was stopped and the mixture allowed to settle for ½ hour. The tri-oil containing residual acid (1-2% HNO_3 and 1-2% H_2SO_4) was transferred to a washing house and the tri-spent acid was slightly diluted with water (in order to precipitate out some additional TNT) and this diluted acid was used for the binitration (see above).

Note: Each nitrating house was provided with an individual fume recovery plant. The gases formed in the nitration were removed through ventillators and forced into absorption towers where they were sprayed with water, thus forming weak nitric acid (50-55% concentration). This acid was removed for use in the mononitration.

D) **Purification of TNT** consisted of the following operations:

The tri-oil (called Rohtri) was given several water washes at 90° and then neutralized at 80° with bicarbonate of soda. The resulting product had a setting point of 78-78.4°, much lower than for pure TNT (80.8°) due mostly to the presence of unsymmetrical TNT's, DNT and other impurities. For further purification, the neutral tri-oil was stirred with an equal amount of water at above 80° and the emulsion cooled to 74-76° with constant stirring to effect crystallization. At this point a saturated solution of Na sulfite (Sellite) was added with continuous stirring. The resulting slurry was filtered and the precipitate washed with water.

Note: The Sellite treatment removed the isomers of TNT (mostly beta-and gamma-) present to the amount of 4-4.5%, tetranitromethane (TeNMe) present to the amount of 0.2-0.3% and some other impurities. Total loss from this treatment was 6 to 8%. The resulting product, called Reintri had a setting point (s p) between 80.0 and 80.6.

E) **Drying, Flaking and Packing** operations were conducted as follows:

The purified TNT was heated to 85-90°, separated (while in the molten state) from water and then dried in special water-heated vessels by bubbling dry hot air (at 85-90°) through the molten mass. The molten TNT could be sent from the driers either directly to a shell-loading plant or to a flaker. The product with a s p of 80.6° or higher was called Grade A, that with a lower s p was Grade B. There was also a Grade UK (umkristallisiert) with s p 80.7-80.8° which was prepd by recrystallizing Grade A TNT from a water emulsion, treating the crystals with a small amount of sellite, rinsing with water and drying.

The yield at the Krümmel Fabrik was 138-142 parts of pure TNT per 100 p of MNT, or 200 p TNT from 100 p of toluene.

Capacity of the Krümmel Fabrik was 3,000 metric tons per month.

Brooks (Ref 6) and Wendes & Little (Ref 10) describe the following method of manuf of TNT at the Allendorf Fabrik of Dynamit A -G:

Semi-Continuous Method consisted of the following:

A) **Mononitration** (continuous process) was conducted in two stages. Toluene and nitric acid were fed into two pre-nitrators where the mixture was vigorously agitated for ½ hour at 35°. About 93% of the nitration was accomplished in these vessels. Toluene was fed in at a rate of 1,000 lb per hour. The resulting emulsion overflowed into one main nitrator and then to a continuous gravity separator which was a rectangular steel box packed with Raschig rings. The mono-waste acid was drawn off through a trapped bottom outlet while the mono-oil went to a washer. Here the oil was washed with water and soda-ash solution and then passed through a series of stripping towers. Live steam was blown through the towers to remove the impurities, such as unnitrated toluene, benzene and paraffins. The refined mono-oil was then sent to the bi-nitrator or shipped to other TNT plants

B) **Bi- and Trinitration** (batch processes) were conducted in much larger nitrators than used in the U S A. As much as 10,000 lb of mononitrotoluene was treated in one batch (about 3 times as much as in the U S A.

The bi-nitration took about 3 hours while the tri-nitration required 6 hours. For this reason there were twice as many tri-nitrators as bi-nitrators.

In the tri-nitrators, the mixed acid (consisting of nitric acid 24, sulfuric acid 76 and water 0%) was added to the crude DNT (bi-oil) while maintaining the temperature at 83°. Then the temperature was raised over a period of 20 minutes to 98° and maintained at this point for 2 hours.

Note: There were no bottom outlets in the nitrators, permitting the drawing of the charge, but in case of fire there was a quick-opening valve which permitted a large stream of 96% sulfuric acid to spray into the nitrator to extinguish the fire (Ref 6, pp 9-10).

C) **Purification of TNT** (at Allendorf). Tri-oil was washed with hot water, and then crystallized from fresh hot water. After drawing off the water and re-slurrying the product, it was treated with a 14% soln of Na sulfite (Sellite) of pH 5 to 6 in such a quantity that there was from 3 to 4 lb of Na sulfite per each 100 lb of TNT. When the 14% soln was mixed with the TNT slurry, there was sufficient water present to bring the strength of soln to about 3% of Na sulfite. The red water was filtered off leaving a TNT with setting point 79.5 to 80°. For a purer product (s p about 80.5°) the partially purified TNT was remelted

by treatment with hot water and then treated while in the molten state with a fresh dilute solution of sellite, using a total of 1 lb Na_2SO_3 per 100 lb TNT.

The resulting red water was decanted and the molten TNT washed twice with hot water. Then the hot wash water was passed through 6 cooling vats to recover the TNT which was dissolved in the hot solution and precipitated on cooling (Refs 6 & 10).

Note: The Allendorf plant consumed 102 lb of nitric acid per 100 lb of TNT (as against 98 to 100 lb in the U S A), and 195-200 lb of oleum (against 215 lb in the U S A). The yield of 80.4°-80.5° TNT was 200 lb per 100 lb of toluene (against 205-208 in the U S A). Cost of 1 lb of TNT was 0.555 mark (about 13¢) (Ref 6, pp 11-15), which was comparable to the price in the U S A.

D) TNT Waste Water Treatment. In order to eliminate the expense of evaporation of waste TNT waters, a special method was developed in Germany (on the laboratory scale) for treating such waters in the cold. This method permitted the recovery of some nitrobodies (Ref 6, pp 27-28). In this process the pH of waste water was adjusted to 5 by adding some sulfuric acid. This was in order to free the organic acids so that they could be extracted by a solvent called Phenosolvan (presumably a mixture of butyl and isobutyl acetates) made by I G Farbenindustrie. After separating the solvent (containing the extracted material) from water by centrifuging, the solvent was distilled off. The nitrobody obtained as the residue in the still was intended for use in commercial explosives. The separated waste water was treated with lime to bring the pH to 7 and then steam distilled in order to recover the dissolved Phenosolvan. This left a yellow colored waste water from which 95% of the nitrobodies had been removed. It contained some inorganic impurities which were assumed to be harmless to fish, etc. This water was allowed to be ditched (Ref 6, p 27).

Continuous Vapor Nitration of MNT to TNT was developed by Dr A. Wille, and a pilot plant was built at Allendorf (Ref 6, p 25). The plant operated at the rate of 10 lbs of TNT an hour, i.e. 3 metric tons a month. It consisted of four major units: a) an atomizer chamber for MNT, b) a tower for nitration, c) a reflux condenser and d) a separator.

The atomizer chamber had one spray nozzle for the MNT feed (which was preheated to 100°) and a 2nd nozzle to introduce nitrogen gas (which was preheated to 160°). The resulting mist (vapor) of MNT in nitrogen was conducted from the atomizer chamber to the bottom of the nitrating tower, 200 mm inside diam and 2.5 m high, made of stainless steel and provided with a stainless steel spiral coil for cooling. The mixed acid, contg 30-35% nitric acid, was also introduced into the bottom of the tower and it flowed upwards with the MNT and nitrogen. The temperature of the material in the tower was maintained at 92° and the current of nitrogen gas provided sufficient agitation.

The acid and nitrobody mixture overflowed at the top of the tower into a rectangular stainless steel box separator, where the TNT settled to the bottom. The waste acid contained 15% total nitric acid and less nitrous than with the batch process. The nitrogen gas together with nitrogen oxides and organic vapors (such as tetranitromethane) was led from the tower to a reflux condenser which returned the condensate to the bottom of the tower (Ref 6, p 25).

Manufacture of TNT at Schlebusch Fabrik of D A-G Batch Process (Ref 6, p 29). The TNT plant at Schlebusch was built in 1906 - the first plant for manufacture of TNT on an industrial scale.

The TNT plant used during WW II was constructed in 1935 and consisted of one line with four houses: bi-, tri-, refining and drying. No mononitration was done because the MNT was received from I G Farbenindustrie in tank cars. In the bi-house batches of MNT up to 3500 kg were nitrated to DNT and the cycle was 3 hours. In the tri-house each batch of DNT was 4300 to 4400 kg (about 10,000 lb). The maximum production of one line was 2500 metric tons/month (about 5.5 million lb).

Continuous Nitration of MNT to TNT at the Schlebusch Fabrik, D A-G (Method of [illegible]) is briefly described in Ref 10. The plant was dismantled after cessation of hostilities and shipped to England where it has never been assembled.

Note: A similar plant is now in operation in Holland (See Dutch Section).

Continuous Nitration of MNT to TNT at the Schlebusch Fabrik, D A-G (Method of Dr Demoeff). Dr Demoeff and collaborators developed and built during WW II a continuous pilot plant producing 300 metric tons per month of TNT. The equipment consisted of nine vessels placed in a row and connected in series. In the first vessel, called the dilutor, the bi-waste acid, (arriving from the 5th vessel) was diluted with water. The diluted acid was transferred to the 2nd vessel, called the extractor, in which the nitrobodies dissolved in acid were extracted with MNT (delivered from one of the I G Farbenindustrie plants). From there the MNT with extracted nitrobodies was transferred to the 3rd vessel, the separator. From the separator the oil overflowed to the 4th vessel, the bi-nitrator, containing some tri-spent acid which was pumped from the tri-nitrator (the 6th vessel). This acid was fortified with some 60% nitric acid. The mixture of bi-oil (DNT) and of bi-waste acid was transferred to the 5th vessel, the separator, and from there the acid went to the dilutor (1st vessel) while the bi-oil went to the trinitrator (6th vessel) which contained the mixed acid pumped from the 9th vessel (serving as a separator for the 8th vessel, called the postnitrator). The next step was separation of the tri-oil (crude TNT) from the tri-spent acid and this was done in the 7th vessel. Then the acid was pumped to the 4th vessel (the bi-nitrator) while the tri-oil went to the postnitrator (8th vessel) which contained fresh strong mixed acid. Then the mixture was pumped to the 9th vessel, the separator, and from there the partially used mixed acid went to the tri-nitrator (6th vessel) while the TNT went to the wash-house. The nitrators were cylindrical vessels, 2 ft inside diam and 3 ft deep provided with coils and agitators. The separators were of the cyclone type, the upper cylindrical part was 3 ft i d and 2 ft high, and the bottom conical part 1 ft deep. The nitrators had a capacity of 200 kg bi-oil and the required amount of acid. The acid consumption for bi- and tri-nitrations was about the same as for the batch process, namely 87 lbs nitric and 195 lbs oleum for 100 lbs TNT produced (Ref 6, p 31).

Continuous Method of Refining of TNT, developed on a pilot scale by Dr Demoeff of Dynamit A-G and tried at Schlebusch, used nine vessels connected in series. The 1st, 3rd, 5th and 7th vessels were washers, the 2nd, 4th, 6th and 8th vessels were separators and the

9th vessel was a dryer. The crude molten TNT (called Rohtri) was transferred from the nitrating plant to the 1st vessel, where it was agitated with hot water. The liquid mixture was transferred to the 2nd vessel (cyclone type separator, similar to the ones used in the nitration plant), where the oil was separated from waste acidic water. Then the oil was transferred to the 3rd vessel where it was washed, while still in the molten state, with a hot dilute solution of sodium sulfite (Sellite) at a pH 5 to 6. After this the tri-oil was separated from waste water (4th vessel) and then washed with fresh hot water (5th vessel). This waste water was separated in the 6th vessel and then in the 7th vessel the TNT was washed again with water for the last time. After separating the last wash water in the 8th vessel, the still molten TNT was dried by bubbling hot compressed air through the liquid in the 9th vessel. Finally the TNT was flaked in the usual manner (Ref 6, p 32).

Continuous Method of Washing of TNT designed by J.Meissner (Ger P 732,742, 1940-1943). The apparatus consisted of six vertical tall cylinders (columns) provided with perforated plates. Each column was enclosed in a steam jacketed kettle so that the TNT could be kept molten throughout the washing process. After separating the crude liquid TNT from the bulk of spent acid, it was emulsified by means of live steam and pre-heated air. The TNT emulsion entered continuously into the bottom of the 1st column and simultaneously some hot water, required for rinsing out the residual acid, was injected. The emulsion moved upwards and, after passing through the perforated plates (installed in order to achieve more intimate mixture between the TNT and washing medium), reached the upper part of the column where the separator was located.

After separating the acidic water, the liquid TNT went to the bottom of the 2nd column. The process was repeated as in the 1st column except that a 5% Na bicarbonate solution was used as the washing medium.

In the 3rd column, the TNT emulsion was washed with hot water, and in the 4th and 5th columns it was washed with a 5% Na sulfite solution in order to remove the beta- and gamma isomers of TNT. In the 6th column, the TNT was washed with hot water, as in the 1st and 3rd columns.

It was claimed that the process possessed the following advantages over the batch processes:

a) Less time consumption due to the fact that much more intimate contact was obtained between the emulsified droplets of TNT and the washing media than was possible with the older method

b) Better yields - 95-96% vs 90-93% with the older batch methods. This was claimed to be due to the fact that as actual contact between the TNT droplets and washing media is very short (less than 5 minutes in each column) there was practically no decomposition or removal of the alpha TNT and only the impurities were affected

c) Better quality of product: setting point 80.5-80.7°, vs 80.3-80.5°C by the older method

d) Greater economy - man power requirements were reduced.

TNT Refining by Nitric Acid. During WW II, the J.Meissner Co developed a refining process with the aim of recovering the TNT impurities for use in commercial explosives. In this process, the crude TNT was crystallized from hot nitric acid of nearly 100% concentration. The manufacturing took place in Belgium but was discontinued because of a serious explosion. This was due to the fact that solutions of TNT in strong nitric acid are very sensitive liquids known as Sprengel Type Explosives.

After this accident Dr A. Wille of Allendorf modified the process to make it non-hazardous.

a) In the new process the crude TNT was dissolved in hot, weak (about 60%) nitric acid and the solution cooled to room temperature. The crystals of purified TNT were separated by filtration from the cold mother liquor which contained most of the impurities and some alpha-TNT. The TNT crystals were washed directly on the filter with fresh 60%, cold (about 10°C) nitric acid and this acid was saved to be used later as a hot solvent for one of the next batches of crude TNT

b) The washed crystals of purified TNT were melted and the molten compound washed with hot water. The resulting acidic water was removed and saved to be used later for absorption tower feed in the acid recovery plant. The molten TNT was further washed 2-3 times with fresh portions of hot water (saving the waste water each time), dried with hot air and then flaked in the usual manner

c) The first 60% nitric acid filtrate (see operation a) was distilled in a stone-lined plastic still using induction heating to eliminate hazards. The average strength of the recovered acid was about 30%.

The purified TNT was of light color and had a s p (setting point) 80.2 to 80.3°. It was claimed to be less exudable than TNT s of s p as high as 80.6° obtained by the Na sulfite purification. This could be due to the fact that nitric acid removes among other impurities the DNT, while Na sulfite does not. For some unknown reason, the TNT refined by nitric acid could not be pelleted. The loss of crude TNT on refining was around 8% (about the same as in sulfite refining) but the nitrobodies recovered from the nitric acid could be used in commercial explosives, while in the Na sulfite process the nitrobodies were decomposed (Ref 6, p 27).

Loading of Ammunition with TNT:

All bombs and shells were cast-loaded and the method is described in Ref 2, pp 14-15, 18-24. Items such as detonators and some boosters were press-loaded and the procedure is described in detail in Ref 3, pp 46-48.

Uses of TNT in Germany During WW II:

A) Straight cast TNT was used in: a) HE shells, such as the 37 mm, 47 mm, 50 mm (trench mortar), 75 mm, 75 mm (smoke) and 105 mm (howitzer) b) AP shells, such as 75 mm, 75 mm (capped), 47 mm (round nose) c) Land mines such as the Tellermine

B) Straight pressed TNT was used in some detonators and boosters. For instance, the booster for the 47 mm HE shell contained 3 pressed pellets of TNT, density 1.49, coated with wax (Ref 5)

C) TNT desensitized with wax. A small quantity was used by the Germans as early as WW I in their AP shells. At the Battle of Jutland, many British ships were sunk by German AP shells filled with desensitized TNT which exploded after penetrating through armor, while most of the German ships were undamaged, because British AP shells were filled with P A which exploded on the surface of the armor before penetration. This was due to the fact that P A is too sensitive to impact.

During WW II, the Germans used some AP and SAP shells filled with blocks consisting of mixture of TNT

with 3 to 10% of Montan wax. The higher wax content was in the case where the shock of impact is more intense. The tail booster consisted of straight compressed TNT.

Following are the names of TNT-wax mixtures used for loading shells: Fillers No 10, No 11, No 12, No 27, No 29, No 30 and No 100 (See under Fillers).

Note: All the above mentioned mixtures, with the possible exception of Filler No 29, were less powerful and brisant than straight TNT, and their velocities of detonation were lower (Ref 4).

D) Mixtures of TNT with various explosives. In some mixtures, such as with RDX or PETN, the TNT was incorporated to make the composition castable and less sensitive to mechanical action than if RDX or PETN was used alone, although the addition of TNT resulted in the lowering of power, brisance and velocity of detonation of the RDX or PETN.

In another group of explosives, the TNT was the principal high explosive component, the other ingredients being added to stretch the available supply of TNT. Among these ingredients were: An nitrate (such as in Amatols and Ammonals), K or Na nitrate (such as in Sodatol), DNB, DNN, TNX, DNA, Ca nitrate, common salt, etc. These explosives can be classed as Ersatzsprengstoffe (q v).

One such mixture, namely TNT & DNA, was used in some hand grenades, because it was presumed that incorporation of a comparatively weak explosive, such as DNA, prevented the formation of excessively small fragments.

There were also several TNT & TNX mixtures and they are described under Trinitroxylol.

Abbreviations: AP Armor-piercing; A/T Antitank; Ca Calcium; D A -G Dynamit Aktiengesellschaft; DNA Dinitroaniline; DNB Dinitrobenzene; DNN Dinitronaphthalene; DNT Dinitrotoluene; GerP German Patent; HE High Explosive; m- meta; MNT Mononitrotoluene; m p melting point; Na Sodium; o- ortho; P Patent; p- para; P A Picric acid; PETN Pentaerythritol tetranitrate; RDX Cyclonite or RDX; SAP Semi-armor-piercing; Tetrite Tetranitromethane; TNT Trinitrotoluene; TNX Trinitroxylene.

References:
1) R.Escales, Nitrosprengstoffe, Veit, Leipzig (1915) pp 142-161, 290-328, and 436-438
2) A.Stettbacher, Schiess- und Sprengstoffe, Barth, Leipzig (1933), pp 261-277
3) O.W.Strickland et al, General Summary of Explosive Plants (Germany), PB Rept 925 (1945), pp 6, 33-38 & 46-48
4) O.W.Strickland et al, Survey of German Practice and Experience in Filling High Explosives, PB Rept 1820 (1945), pp 6-8, 14-15 & 18
5) Anon, Data on Foreign Explosives, PB Rept 11,544 (1945), Part II; Tables I & II
6) C.H.Brooks, TNT Manufacture in Germany, PB Rept 22,930 (1945)
7) Allied & Enemy Explosives, Aberdeen Proving Ground, Maryland (1946), p 79
8) H.Walter et al, German Development of High Explosives, PB Rept 78,271 or FIAT Final Rept 1035 (1947), p 2
9) A.Stettbacher Spreng- und Schiessstoffe, Rascher, Zürich (1948), pp 73-75
10) J.C.H.Vanders & J.R.Little, Report on Western European Processes for the Continuous Production of TNT, U S Army, ... Kankakee Unit, Joliet Arsenal, Joliet, Illinois (1955)

Trinitroxylol (Trinitroxylene) (TNX) is described in the general section under Xylene. The German TNX prepd by nitrating commercial xylene was a plastic product contg about 85% of trinitro - m - xylene of m p 182°, the rest being a liquid mixture of nitrated o- and p-xylenes. (Refs 1 & 4).

In order to stretch the available supply of TNT, the Germans, during WW II, used some explosive compositions which contained as high as 45% TNX.

Following are some examples of such explosives:

a) Mixtures of TNX 20-25 and TNT 80-75% with a m p average of about 77° were used for cast-loading some bombs and shells. For their manuf xylene and toluene were nitrated separately by continuous methods to form MNX and MNT and the mixture of the two mononitrocompounds in the approximate ratio of 1:4 was nitrated directly to the trinitro stage, but the sulfite refining was omitted (Refs 2 & 3)

b) A mixture of TNX 45, tetryl 50 and TNT 5% with a m p about 80° and suitable for cast-loading shells, etc, was prepd by nitration of a mixture of MNX and dimethylaniline and incorporation in the resulting trinitrated product of 5% of TNT. The mixture was more brisant than TNT but required a stronger booster (Ref 2, p 11).

(See also under Ersatzsprengstoffe).

References:
1) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933) pp 277-8
2) PB Rept 1820 (1945), p 11
3) PB Rept 22,930 (1945), p 15
4) A.Stettbacher, Spreng- und Schiessstoffe, Zürich (1948), p 75.

Tri-Salz. See Trimethylammonium Nitrate in the general section.

Trisalitol. See Filler No 108(?) under Fillers.

Tri-Trinol. An explosive consisting of 2 parts of Tri (TNT) with 1 or 2 parts of Trinal (TNN) used during WW I for filling some small caliber shells. Compressed P A was used as a booster.

Reference: T.L.Davis, Chemistry of Powder and Explosives, Wiley, N Y (1943), p 158.

Triwestphalit SH. An explosive used in potash mining. It was prepd by W A S A -G by crushing and grinding the double-base propellants left as surplus after WW I.

Reference: Naoúm, Nitroglycerin, Baltimore (1928) p 499.

Trizin, Tricin, Trinitroresorcin, Styphninsäure oder Oxypikrinsäure (Trinitroresorcinol or Styphnic acid) is described in the general section under Resorcinol. A short description of Trizin is given by Stettbacher (Ref 1 and 3). A method of prepn of the Trizin as practiced in Germany during WW II is given in Ref 2. Trizin was used for prepn of its lead salt, called in German Trizinat and in English lead styphnate.

References:
1) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 287
2) PB Rept 95,613 (1947), Section M
3) A.Stettbacher, Spreng- und Schiessstoffe, Zürich (1948), p 98.

Trizinal, Trizinat, Tricinat, Blei Trizinat oder Blei Styphnat. See Blei Trinitroresorcinat and also in the general section under Styphnic Acid.

Trizinat und Tetrazen Zusatz. Same as Sinoxydsatz.

Trobach Priming Mixture, patented in 1890, contained Ba picrate 70, K chlorate 15 and 15% of a double salt prepd in the following manner:

Pyridine was added slowly to a soln of a metallic nitrate (such as of Cu, Ni or Bi), until the characteristic odor of pyridine became evident. The resulting crystals were dried and incorporated in the above mixture.

Reference: Daniel, Dictionnaire, Paris (1902), p 776.

Troisdorf Fabrik D A -G was one of the principal German factories for the manufacture of priming and initiating explosives and devices. Its WW II developments and activities are briefly described by W.Taylor et al, BIOS Final Report 644 (1945).

Trolit. Plastic material consisting of either polystyrene or polystyrene copolymers manufd during and after WW II by the Dynamit A -G, Troisdorf, Bez Köln. Some fuze bodies, such as "WgrZ T" were made from Trolitul.

References:
1) W.Krannich, Kunststoffe im technischen Korrosionsschutz, Lehmann, München-Berlin, (1943), p 425
2) H.Saechtling u W.Zebrowski, Kunstoff-Taschenbuch, Hanser, München (1952), pp 240-241, 257
3) H.A.Tisch and R.W.Kuchkuda, Picatinny Arsenal, Dover N J; private communication (1955).

Tropföl oder Flüssige Öl (Drip Oil or Liquid Oil) is described in the general section and also in A.Stettbacher, Schiess- und Sprengstoffe (1933), p 261.

TSMV 1-101. See Schiesswolle 18.

T-Stoff (T-Stuff or T-Substance) is the German designation for concentrated hydrogen peroxide (Wasserstoffperoxyd). T-Stoff was a clear, viscous liquid contg 80-85% H_2O_2 and 20-15% H_2O. It was fairly stable at ordinary temperature and pressure when in the presence of small quantities of stabilizers such as phosphoric acid. However, despite the greatest care, it was not possible to prevent a slow decomposition of the H_2O_2 into oxygen and water over a long period of time.

T-Stoff was best stored in aluminum receptacles which had been previously treated with an acid and trisodium phosphate. It can also be kept in glass vessels, but in any case extreme care must be taken to exclude any dust (inorganic or organic) or any other impurities. Other T-Stoff resistant materials reported were: copper-free aluminum alloys, chromium steels (with not less than 13% Cr), polyvinylchloride plastic (when using tricresylphosphate as a softener) and polyethylene plastic. The Buna S and polyvinylchloride without a softener were less resistant whereas the polyamid was not resistant at all (CIOS Rept 30-115, pp 12-13).

In order to determine the strength of T-Stoff, either the hydrometer or titration with K permanganate was used.

T-Stoff was used as an oxygen carrier in some rocket propellants, as for instance in the Hecht guided missile which was propelled by a mixture of T-Stoff and Na or Ca permanganate. These mixtures were called Z-Stoff.

According to CIOS Rept 30-115, p 8, when T-Stoff was decomposed by a catalyst, such as Z-Stoff (see above) or MP-14 (q v), superheated steam was formed (together with oxygen) because about 552 kcal/kg were liberated and a very high temperature (480° C) was attained. The steam obtained with a solid catalyst (such as MP-14) was suitable for driving the turbine, whereas the steam obtained with Z-Stoff was suitable for driving rockets or ATO (assisted take-off) units. The steam obtained with Z-Stoff was not suitable for driving turbines because it contained small particles of MnO_2. When T-Stoff was mixed with B-Stoff (hydrazine hydrate) in the presence of K cuprocyanide, the resulting liquid was found to ignite spontaneously.

One of the most interesting applications of T-Stoff was as a source of power for submarines as proposed by Dr Hellmuth Walter. (See U-Boot Walter). Seven such submarines (300 to 500 tons each) were accepted by the German Navy up to the end of WW II.

Dr Walter, who is now working in the U S A, recently published a paper (Ref 7) describing hydrogen peroxide as a source of power. Beside submarines, he lists the following German devices where hydrogen peroxide was used as a source of power:

a) A 500 kg ATO (Assisted Take-Off) H_2O_2 mono-fuel unit

b) A 300 kg thrust, rocket propulsion unit for guided missiles

c) A bipropellant 1000 to 1500 kg ATO

d) A catapult with hydrogen peroxide propulsion unit (decomposition only) for launching V-1 s

e) Controllable propulsion of a 750 kg thrust unit for the Messerschmitt 263

f) Rocket training airplane and a controllable power plant giving to 2000 kg thrust for the Messerschmitt 263 B.

References:
1) Dr Nitschmann, Physical and Chemical Investigations of T-Stoff Solutions, I G Farbenindustrie Rept 597, Oppau, Germany (1944)
2) H.Walter, Report on Rocket Power Plants Based on T-Substance, NACA Rept No 1170 (translated from the German)
3) Logan McKee, Mechanical Engineering 68, 1045-48, (1946), Hydrogen Peroxide for Propulsive Power, Production and Use by the Germans during WW II
4) E.S.Shanley & F.P.Greenspan, Ind & Eng Chem 39, 1536-43 (1947), Highly Concentrated Hydrogen Peroxide, Physical and Chemical Properties
5) R.Simard, The Engineering Journal of Canada 31, 219-25 (1948)
6) F.Ross, Jr, Guided Missiles, Lothrop etc, N Y (1951), pp 45-6
7) H.Walter, Jet Propulsion 24, 166-171 (1954), Experience with the Application of Hydrogen Peroxide for Production of Power.

Note: According to H.A.Curtis, CIOS Report 28-62 (1946), p 23 the code name T-Stoff was used for 82% hydrogen peroxide, while the code names Aurol, Neuralin and Subsidol were used for any 80-86% hydrogen peroxide. According to R.C.Stiff, CIOS Rept 30-115 (1945), p 8, the T-Stoff was also called Ingolin.

T-Stoff. Besides being a designation of a concentrated hydrogen peroxide (see above), the word T-Stoff was used to designate the lacrymator (Tränenstoff) consisting of a mixture of bromides of o-, m- and p- isomers of xylene.

T-Stoff (S). Hydrogen peroxide containing about 20% water and stabilized with phosphoric acid (150 mg per liter). Specific gravity at 20° C, 80% solution 1.34, 83% 1.355 and 85% 1.364. Decomposition number (q v) less than 5. Used as a source of oxygen in liquid rocket propellants.

Reference: R.C.Stiff, CIOS Report 30-115 (1945), p 9.

T-Stoff (SS). Hydrogen peroxide contg about 20% of water and stabilized with [illegible]-quinoline (400 mg per liter). Decomposition Number (q v) less than 1. Specific gravity

at 20° same as T-Stoff (S). Used in liquid rocket propellants.
Reference: R.C.Stiff, CIOS Report 30-115 (1945), p 9.

Überchlorsäure. See Perchloric Acid in the general section.

Übertragungsdistanz (Transference Distance). According to A. Stettbacher Schiess- und Sprengstoffe, Leipzig (1933), p 46, the distance (d) in meters may be expressed as:

$$d = k\sqrt{c}\text{, where}$$

(c) is the weight of an explosive in kg and (k) is the constant equal to about 2.5.
(See also Gap Test in the general section).

Übertragungskoeffizient oder Sensibilitätskoeffizient (Transmission Coefficient or Sensitivity Coefficient). According to Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 45, the coefficient of transmission of detonation by influence (Le) is calculated from the following equation:

$$Le = c/c_1\text{, where}$$

(c) is the weight (such as 50 g) of an explosive to be initiated by influence and (c_1) is the weight of a standard explosive, such as picric acid (P A) serving as an initiator by influence.

If the distance between explosive charges is 15 cm, then in order to detonate 50 g of P A (c = 50), it would require 50 g of P A (c_1 = 50). This would give for the (Le) the value of 50/50 = 1.

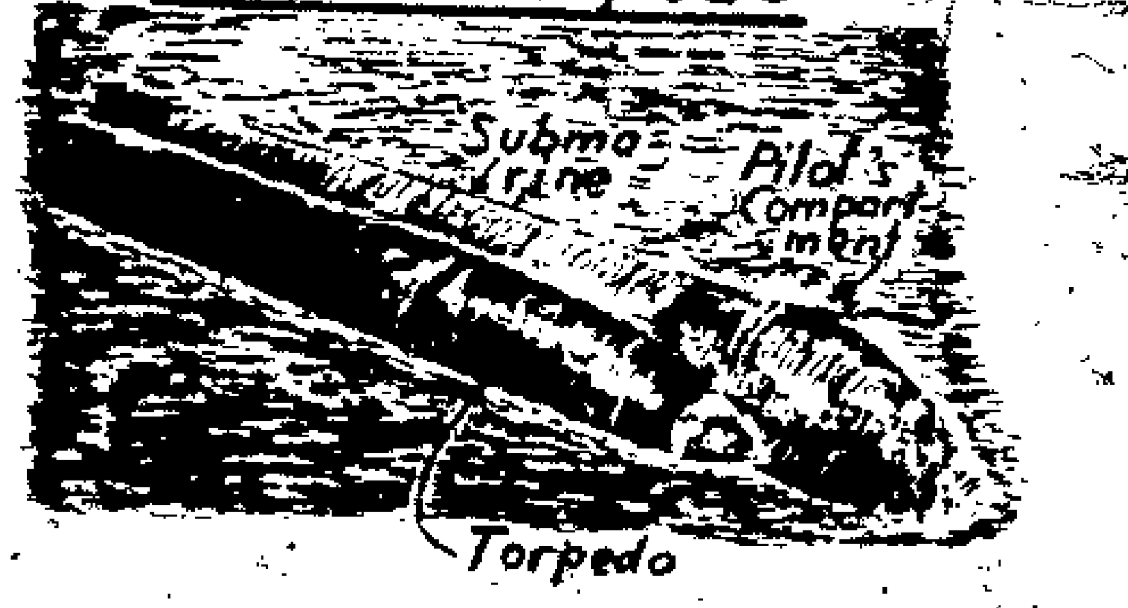
In order to detonate 50 g of TNT (c = 50) it would be necessary to use 68 g of P A (c_1 = 68) while for 50 g of tetryl only 28 g of P A would be required. This gives for (Le) the value of 50/68 = 0.78 for TNT and the value of 50/28 = 1.80 for tetryl.
Note: The higher the value of (Le), the more sensitive is an explosive to initiation by influence.

U-Boot, One-Man; One-Man Submarine or One Man Torpedo (Ein-Mann Torpedo). This device consisted of a small one man submarine to the bottom of which a torpedo was attached by means of shackles. The combination was propelled by an electric motor in the submarine operated by storage batteries. The pilot brought the device to within a fairly short distance of the target (such as an enemy ship, dock, warehouse, etc) before releasing the torpedo. The torpedo was aimed by lining up the submarine with the target. After firing the torpedo, the pilot returned to his base or to his "mother" ship (Refs 1 & 2).
Note: Some of submarines were propelled by internal combustion engines (Ref 2).

References:

1) Anon, Field Artillery Journal 34, p 505 (1944)
2) Private communication from an engineer who worked on their construction and who requested that he remain anonymous.

One-Man Torpedo



U-Boot, Pocket (Pocket Submarine). See Seehund.

U-Boot-21 oder Unterseeboot 21 (U-Boat 21) (Sous-marin 21, in French) was a submarine developed in the last part of WW II but not produced in large quantity. It was 77 m long, 6½ m wide, displaced 1600 tons and was provided with 5000 HP Diesels and 5000 HP electric motors. Its speed in submerged condition was 18 knots against 7 knots of the older submarine models "7" and "9". The U-boot-21 could travel as much as 30,000 miles without refuelling or restocking.
Reference: A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 24-26.

U-Boot Walter (U-Boat of Walter) (Submarine With Chemical Propulsion) (Sous-marin à propulsion chimique, in French). In order not to be dependent on atmospheric oxygen for the operation of submarine Diesel engines when in submerged condition, H.Walter and collaborators designed a device in which concentrated hydrogen peroxide (T-Stoff) was catalytically decomposed in the presence of Ca permanganate into water and oxygen. The oxygen was used for operating the Diesel ... same time, the energy liberated on decomposition of the hydrogen peroxide, which amounted to 690 kcal/kg (calculated for 100% peroxide), was utilized to operate a gas turbine directly connected to the propeller shaft ... a by-product of this reaction pure water was obtained which was used for drinking and cooking purposes.

According to Ref 5, the above system was called "Closed Cycle Diesel Development for Submerged Propulsion", and the idea for such an engine goes back to the time of WW I when the Germania Werft at Kiel tried to use compressed oxygen for Diesels. No work on the subject was done until 1939-1940 when the German Navy requested some firms (such as Zeppelin GmbH, Kommandit-Gesellschaft Walter) and research institutions (such as the Forschungsinstitut für Kraftfahrzeuge, under the direction of Prof Kamm and Dr Huber) to resume the project. Besides the above mentioned Walter system using hydrogen peroxide as a source of oxygen, there was also a system developed at Prof Kamm's laboratory which used compressed oxygen. A submarine, using compressed oxygen, designated as Type XVIII K (called also Seehund), was nearly completely built at the Germania Werft, Kiel, using finished Blohm & Voss Type XVII hulls, Daimler-Benz engines and two outboard cylinders with compressed oxygen. The Kamm's equipment was somewhat bulkier than that of Walter. In addition to the type XVII K submarine, it was planned to build a submarine with a smaller engine and to use liquid oxygen carried in two insulated tanks. The work on the closed cycle engine project did not progress very fast as it was considered by the High Command to be of secondary importance.
(See also Seehund and under T-Stoff).
Note: Rocket power plants constructed at the Walter Werke, Kiel are described by R.C.Stiff, CIOS Rept 30-115 (1945).

Note: According to Chem Engrg News 32, 1356 (1954), the British, in the yard of Vickers-Armstrong, at Barrow-in-Furness, launched a submarine called the "Explorer" which is to be propelled by hydrogen peroxide.

References:

1) A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 26-31
2) R.Simard, Eng J of Canada 31, 219-25 (1948), CA 42, 5622 (1948)
3) H.Schaeffer, U-Boat 997, Norton, N Y (1953), pp 181-2
4) H.Walter, Jet Propulsion 24, 165-9 (1954)
5) A.H.Schilling, German Naval Closed Cycle Diesel Development for Submerged Propulsion, CIOS Report 30-76 (1945).

Underwater Explosions and Explosives. See Unterwassersprengungen und Sprengstoffe.

Ungefrierbare Dynamite oder Schwergefrierbare Dynamite (Non-freezing Dynamites or Difficultly Freezing Dynamites) are described in the general section as Low-freezing Dynamites.

The following substances or their mixtures were used in Germany in order to make the NG containing explosives non-freezing at winter temperatures:
Nitroglycol, dinitrochlorohydrin, dinitroglycerin, tetranitrodiglycerin, dinitroformin, dinitroacetin, butyleneglycoldinitrate and aromatic nitrocompounds such as MNB, MNT, DNT, etc.

References:

1) P.Naoúm, Nitroglycerin, (1928), pp 356-381
2) A.Stettbacher, Spreng- und Schiesstoffe, (1948), p 61.

Unknown-Name Explosives. The following German compositions were described in Allied and Enemy Explosives, Aberdeen Proving Ground, Maryland (1946), and other sources, but for which no names were given:

a) RDX/TNT-50/50 and 53/47. Used in shaped charge ammunition (shells, grenades and demolition charges (cast-loaded)).

b) RDX pellets embedded in TNT. Used in 4000 kg bombs (cast-loaded)

c) RDX/TNT/Wax - 51/48/1, 55/42/3 and 58/40/2. Used for case-loading various shells.

Unterwassersprengstoffe (Underwater Explosives). Extensive study of underwater explosions (Unterwassersprengungen) and of German underwater explosives was conducted by Dr A.Stettbacher, Zürich, Switzerland. He described some of his investigations in books and papers published in Germany and Switzerland (See Refs 1-5). Some additional information on German and Swiss explosives was communicated to the author by Dr S. during his stay in New York in the summer of 1954. Some investigation on German aluminized underwater explosives was made by H.Muraour (See under Aluminized Explosives). Extensive information on the composition and effectiveness of various underwater explosives may be found in Naval Technical Mission, Europe Technical Reports (e g Repts Nos 227-45, 547/45 & 548/45), some PB reports (e g PB No 1820), some British Armament Research Department, some British Mine Design Dept and some German reports issued by the Chemisch-Physikalische Versuchsanstalt and other institutions. One of the reports is entitled Bericht über die Arbeitstagung Unterwassersprengungen Amtsgruppe Mar Rüst/FEP in OKM, Tagungsbericht Nr 8, Oktober 1945. The data from these papers was compiled by J.S.Coles in an excellent report entitled "Summary of Underwater Explosive Comparisons", NDRC No A-363, OSRD No 6241. Although this report was written about 1945, it is still classified. For this reason the values of underwater effectiveness given in this report are not included in this work.

According to Stettbacher the principal explosives used during WWI for loading the sea mines (Seeminen), depth charges (Tiefbomben) and torpedoes (Torpedos), consisted of TNT and HNDPhA (hexanitrodiphenylamine). One such explosive composition consisted of TNT/HNDPhA - 60/40, while another contained TNT/HNDPhA-35/65. The latter mixture was called Schiesswolle neuer Art (Schw nA).
Note: It is of interest to report that previous to WWI and as early as 1898, the Germans, in their underwater ammunition, used mixtures of TNT, HNDPhA, TeNA (tetranitroaniline, called Tetra in Germany) and TNB (trinitrobenzene). Straight TNT was also found to be suitable as an underwater explosive. Towards the end of WWI large proportions of aluminum powder were introduced in underwater explosives. One such mixture, known as Schiesswolle 18 (abbreviated to Schw 18 and later called S-1) was used extensively during WWII. Its composition was TNT/HNDPhA/Al - 60/24/16.
Note: Stettbacher's reported analysis of this mixture was 61.8/23/15.2. He stated that it was very effective in all kinds of underwater charges.

At about the same time as above (1918), a mixture in which PETN was used in lieu of HNDPhA was introduced. It was called Schw 19 and contained PETN/TNT/Al 25/48/27.

When Germany started to rearm (about 1936), the mixture called Schw 36 or S-2 (TNT/HNDPhA/Al - 67/8/25) made its appearance. At about the same time the Chemisch-Physikalische Versuchsanstalt (CPVA) proposed several explosives in which RDX (Hexogen) was used in lieu of HNDPhA. (See Triolens 105 and 106, known also as Filler No 105 and Filler No 106). Similar explosives: Triolen 107 (See Filler No 107), S-17 or Mixture 1 (RDX/TNT/Al - 10/50/40) and Tritolital (q v) appeared before and during WW II.

Several compositions in which ammonium nitrate was used as one of the ingredients were introduced before and during WW II. They included Schw 39 or S-3 (NH_4NO_3/HNDPhA/TNT/Al ground - 30/5/45/20), Schw 39a (NH_4NO_3/HNDPhA/TNT/Al ground - 5/10/50/35), Mixture 2 (NH_4NO_3/RDX/Al/Wax - 35/28.5/35/1.5), S-16 (NH_4NO_3/Ethylenediaminedinitrate/RDX/Al/KNO_3/$NaNO_3$-32/10/10/40/2/6), Some Amatols, among them the Amatol 39 (q v), ASN explosive (NH_4NO_3/Dicyandiamide/PETN - 70/10/20) and ASN + 10% Al explosive (NH_4NO_3/DCDA/PETN/Al - 63/9/18/10).

In addition to the above mentioned ASN and Schw 19, the following other underwater explosive compositions contained PETN: PETN/Al powder/Wax - 66.5/30/3.5 and a mixture of Nipolit (q v) 70 with ground Al 30%. One of the advantages of Nipolit is that it can easily be machined and is suitable for use either for cased or uncased charges.

Mixtures of PETN with NG (nitroglycerin), in which may be incorporated some collodion cotton, were proposed in 1929 by A.Stettbacher under the name of Pentrinite. (See Swiss section of this dictionary). These mixtures were found to be effective in underwater explosions.

Below are listed additional explosives proposed before and during WW II for use in underwater ammunition. It should be noted that some of these explosives were only experimental.
Straight TNT, TNT/Al - 75/25 & 60/40, TNT/RDX - 55/45, RDX/Al/Wax - 76/20/4 & 67/30/3 (called respectively Hexal 80/20 & Hexal 70/30), S-4 (matrix S-2 & pellets S-3), S-5 (matrix S-1 & pellets S-3), S-6 (Dinitronaphthalene/HNDPhA/TNT/Al - 20/24/40/16), S-7 (DNN/HNDPhA/Trinitrochlorobenzene/Al - 15/24/45/16), S-8 (HNDPhA/Trinitrobenzene/TNT/Al - 24/6/54/16), S-9 (matrix S-1 & pellets S-6), S-10 (matrix S-8 & pellets S-6), S-11 (matrix S-1 & pellets S-7), S-12 (matrix S-8 & pellets S-7), S-13 (HNDPhA/Trinitrochlorobenzene/Al - 24/60/16), S-14 (matrix S-1 & pellets S-13), S-15 (matrix S-8 & pellets S-13), S-16 (see above), S-17 called also Mixture 1 (see above), S-18 (matrix S-17 & pellets S-16), WASAG-1 (NH_4NO_3/HNDPhA/TNT/Al - 30/5/55/10), WASAG-2 (HNDPhA/TNT/Al - 24/66/10), WASAG-3 (HNDPhA/TNT/Al - 15/75/10), WASAG-(1+2) (matrix WASAG - 2 & pellets WASAG - 1), WASAG(1+3) (matrix WASAG-3 & pellets WASAG-1).

The following two experimental mixtures proved to be very promising as underwater explosives: NH_4ClO_4/RDX/Al - 50/10/40 and TNT/NH_4NO_3/Al - 57.1/28.6/14.3. The first mixture is about 2½ times as effective as TNT, while the second mixture has the advantage that it can be pressed to a high density of 1.84.
(See also explosives S-6, S-6 modified, S-16, S-19, S-22, S-26, E-4 and KMA listed under Ersatzsprengstoffe).

References:

1) A.Stettbacher, S S 25, 233-34 (1930) (Explosionen unter Wasser. Torpedo Wirkung)
2) A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), pp 396-401
3) A.Stettbacher, Protar 8, 83-92 (1942), Kriegssprengstoffe
4) A.Stettbacher, Protar 9, 33-45 (1943), Über die Wirkung von Torpedos, Minen, und Tiefenbomben unter Berück-

sichdigung der deutsche Marine-sprengstoffe, vom letzten und heutigen Weltkrieg)
5) A.Stettbacher, Spreng- und Schiessstoffe, Zürich (1948), pp 135-140
6) J.S.Coles et al, NDRC Report No A-363, OSRD Rept 6241 (about 1945), pp 51-9 (Confidential)
7) R.H.Cole, Underwater Explosions, Princeton University Press, Princeton, New Jersey (1948), pp 147-424
8) O.W.Stickland et al, PB Rept 1820 (1945)
9) A.Stettbacher of Zürich, Switzerland; private communications.

Unterwasserzünder (Underwater Igniter or Primer). Described in C.Beyling and K.Drekopf, Sprengstoffe und Zündmittel, Berlin (1936) pp 174, 225 & 237.

Uresin B. Plasticizer for NC made from cellulose acetate and formaldehyde (CIOS 28-62, p 24).

V-1 oder Vergeltungswaffe Eins (V-1 or Revenge Weapon One). The official German designation was FZG-76 and the British name Buzz Bomb. V-1 was a pilotless plane(winged rocket) which could fly at a speed of 300-360 mph at a height between 2,000 and 3,000 feet and to a distance of 220 miles. It could be launched from a catapult, or released from a piloted plane. The body of the V-1 rocket was cylindrical in shape, tapering toward the nose; diameter 2' 7" and total length 21' 5". Fully loaded it weighed 4,750 lb. It was propelled by a pulse-jet engine using 150 gallons of gasoline for fuel and compressed air as the oxidizer. The warhead contained some newly developed explosives (see below), which could withstand high temperatures. These rockets were fired against England, beginning in June 1944, and caused considerable damage.

References:

1) A.Ducrocq, Les Armes Secrètes Allemandes, Berger-Levrault, Paris (1947), p 35
2) F.Ross, Jr, Guided Missiles, Rockets and Torpedoes, Lothrop, Lee, Shephard, N Y (1951), pp 14-20
3) K.W.Gatland, Development of the Guided Missile, "Flight" Publications, London (1952)
4) Anon, German Explosive Ordnance, TM 9-1985-2 (1953), pp 205-10
5) W.Dornberger, V-2, The Viking Press, N Y (1954), p 93-98
6) A.S.Locke et al, Guidance, Van Nostrand N Y (1955), pp 34-5, 56-7, 71 & 76 (Book 1 of the "Principles of Guided Missile Design", edited by Grayson Merrill)

(See illustration on next page).

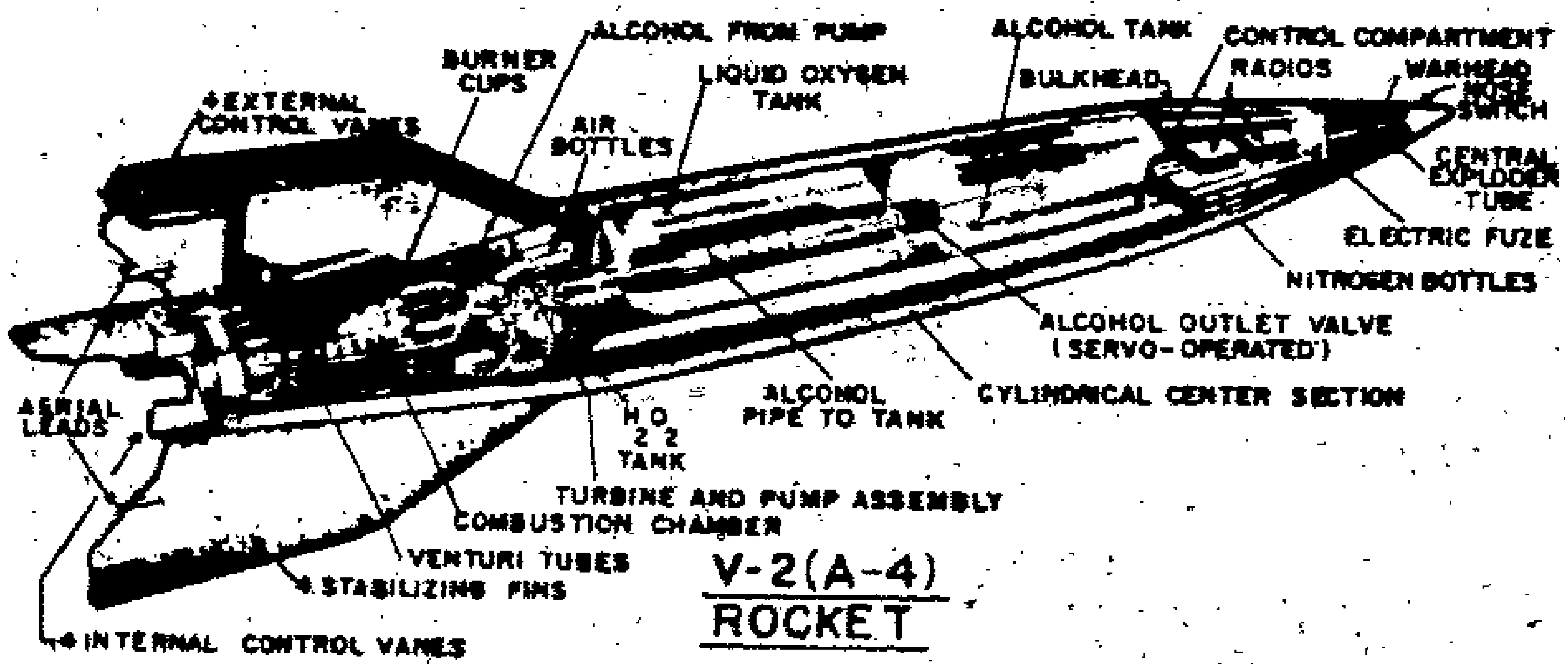
V-2 oder Vergeltungswaffe Zwei (V-2 or Revenge Weapon Two). The official German designation was A-4. V-2 was a rocket provided with 4 stabilizing fins. It could fly with a speed up to 3600 mph to a distance up to 220 miles and at altitudes up to 50-60 miles. The body of the rocket was cylindrical in shape with a cone tapering to a sharp point. The largest diameter was about 5' and the overall length was 46'. Fully loaded it weighed about 14 tons, which included 9 tons of fuel supply and about 1 ton of special explosive that could withstand high temperatures in the warhead. The first of these rockets was fired against England in Sept 1944. A total of 1115 V-2 rockets were fired up to April 2, 1945, and they caused considerable damage especially in London and vicinity.

Table 62 gives some additional information on V-2, as taken from the book of Gatland (Ref 3, p XVII).

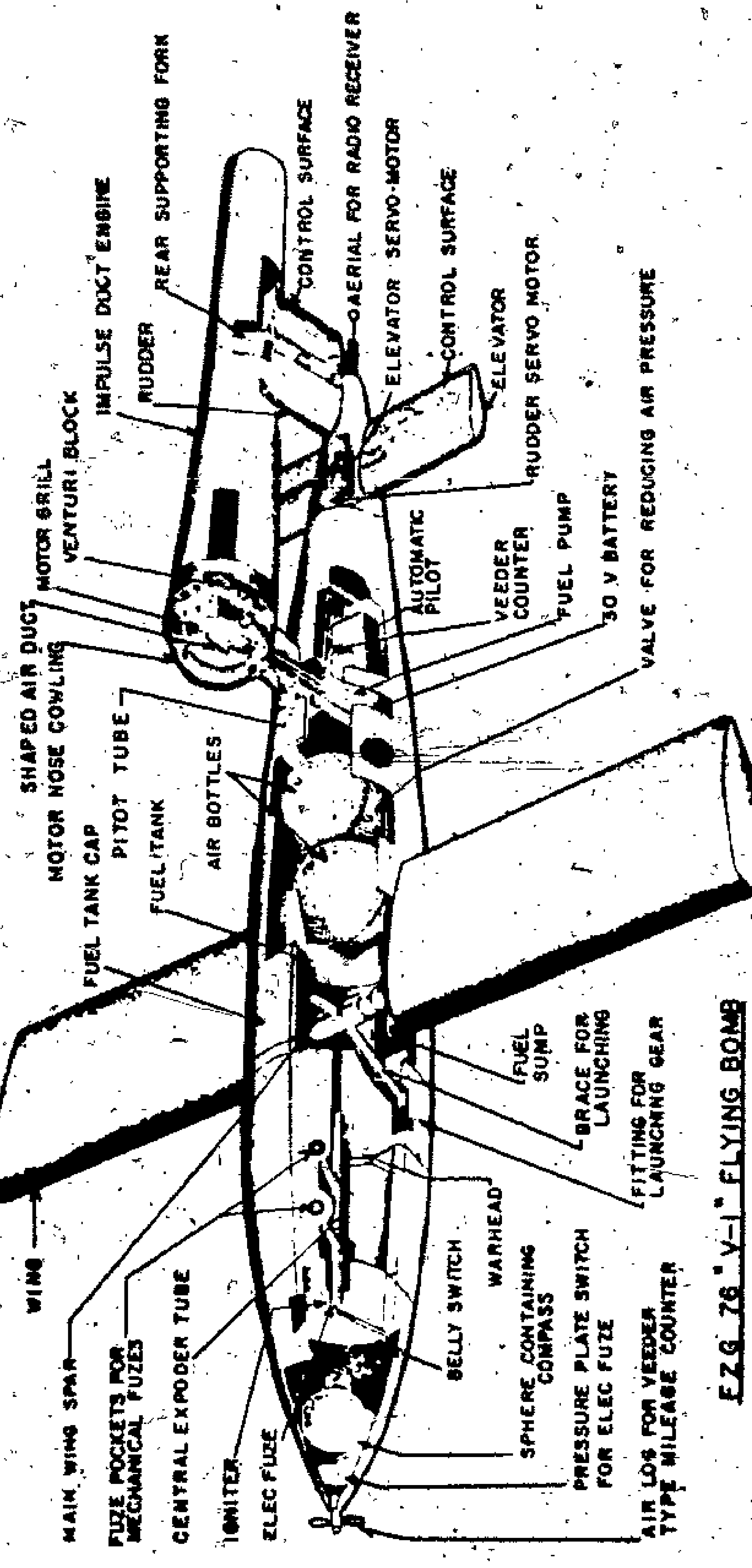
TABLE 62

Characteristics of V2	Metric	U S
Length	14 m	46'
Diameter of body	1.65 m	5' 5"
Take-off weight	12,900 kg	28,440lb
Payload	1000 kg	2205lb
High explosive carried	750 kg	1654lb
Alcohol (Contg 25% water)	3965 kg	8740lb
Liquid oxygen	4970 kg	10,957lb
Thrust at take-off	25.000 kg	55,100lb
Thrust gain near Brennschluss	4200 kg	15,250lb
Fuel consumption per second	127 kg	280lb
Alcohol/oxygen ratio in mixture	0.81	
Maximum burning time	65 sec	
Temp in motor	~2700° C	~4890°F
Pressure in motor	15.45 atm	227 psi
Nozzle expansion ratio	15.45:0.85	
Exhaust velocity	2050 m/sec	6725 ft/sec

References:
(Same as given under V-1).
(See illustration below).



V-2 (A-4) ROCKET



FZG 76 "V-1" FLYING BOMB

V-1 and V-2 (Explosives Used in Verhende of). At first both the V-1 and the V-2 used mixtures of TNT and Am nitrate. These were replaced by Amatol 39 (DNB 50; Am nitrate 35 and RDX 15%) or by Amatol 40 (Dinitro-anisole 50, Am nitrate 35 and RDX 15%). While Amatol 40 was suitable for cast-loading, the Amatol 39 gave occasional cavities when cast-loaded alone.

In order to eliminate the cavities in cast-loading, Römer proposed later to pour the Amatol 39 over pieces of Biscuit Mixture A which consisted of Am nitrate 50, technical Ca nitrate 25, PETN 10 and RDX 15%.

Still later in the war, when the shortage of aromatic compounds became more acute than ever, it was proposed to use mixtures not containing the nitroaromatics, as for instance: technical Ca nitrate 55, powdered peat 5, Al powder 10 and 30% of 90/10 methyl nitrate/benzene mixture, called Myrol (q v).

Reference: G.Römer, PBL Rept 85,160 (1946), p 19.

V-1 and V-2 (Propellants Used in). As was mentioned under Rocket Propellants (Liquid), the Germans used compressed air as the oxidizer and gasoline as the fuel in the V-1. For the V-2 rocket they used liquid oxygen as the oxidizer and ethanol containing some water as the fuel.

Note: According to J.G.Tschinkel, Chem Engrg News 32, 2584 (1954), water was added to alcohol in order to keep the flame temperature as low as possible to avoid damage to the combustion chamber of the rocket motor. For the same reason fuels of higher heating values, such as gasoline, were not used in these rockets. It was found that a mixture of alcohol and 25% water had a flame temperature 7% lower than pure alcohol while its exhaust velocity was only 3.5% lower. This means that on adding 25% of water to alcohol, it was possible to use a somewhat lower structural strength for the motor without sacrificing too much in performance. The same author on p 2585 states that in 1944 preparations were made to replace liquid oxygen in the V-2 with absolute nitric acid.

V-3 (Vergeltungswaffe Drei). See Hochdruckpumpe.

V-22 Delay - Igniter Unit was used in type 1 of the 15 cm RSSG Rocket, briefly described under "Pyrotechnic Anti-pathfinder Devices". The V-22 consisted of a steel tube filled with delay composition, and was screwed into the rocket chamber head. The hot gases from the burning propellant ignited the delay composition which burned for 22 ± ½ seconds under a pressure of about 200 atmospheres. When the delay had burned through, a shallow dish-like structure containing the black powder expelling charge was ignited. The delay compositions which were employed were actually tracer compositions, e g Sr nitrate 55.1, Sr carbonate 5.0, Mg (coarse) 17.6, CPVC (chlorinated polyvinyl chloride) with 63% chlorine 9.3, synthetic phenol-formaldehyde resin 10.0 and rosin 3.0%.

Note: All Mg (coarse) had to pass through a sieve with 1 mm openings (No 16) and be retained on a sieve with 0.15 mm openings (No 100), while 60% was required to be retained on a sieve with 0.3 mm openings (No 30). The type of CPVC containing 63% Cl was called Igelit PCU.

Reference: H.J Eppig, CIOS Report 32-56 (1945), pp 19-21.

Verbrennungswärme (Heat of Explosion). See general section.

Vernichtung von Sprengstoffen und Pulvern (Destruction of Explosives and Propellants), Beseitigung oder Unschädlichmachung von Explosivstoffen (Eliminating or Making Explosives Harmless). See general section under individual explosives.

Verpuffungstemperaturprobe (Deflagration Temperature Test), Entzündungspunktprobe (Ignition Point Test) is described in the general section under Ignition Temperature Test and also in the following references:

1) A.Stettbacher, Schiess- und Sprengstoffe (1933), pp 373-5
2) Kast-Metz, Chemische Untersuchung der Spreng- und Zündstoffe (1947), pp 341-345
3) A.Stettbacher, Spreng- und Schiesstoffe (1948), p 120.

Verstärktes Chromammonit (Reinforced Chromammonite). One of the safety explosives in which TNT was the active base: TNT 12.5, Am nitrate 70.0, K nitrate 10.0, Am chrome alum 7.0 and vaseline 6.5% (Total adds to 106%).

Reference: Colver, High Explosives (1918), p 250.

Versuchsgrube GmbH, Tremonia. Experimental Mine at Dortmund, located previously to 1943 at Hibernia Mine, Gelsenkirchen, was used for the investigation of mining explosives, such as methods of stemming in bore holes, ignition of gas and coal dust, relative safety of sheathed explosives, photographic study of flames produced at the bore-hole mouth by different explosives with various methods of loading, etc.

Reference: BIOS Final Rept 1266 (1947), pp 3-4.

Versuchsstrecke (Testing Gallery). See Schlagwetter-versuchsstrecke and also the general section under Galleries, Testing.

Versuchsstrecke, Dortmund-Derne (Testing Gallery at Dortmund-Derne) was used for the following official tests of permitted explosives (Wettersprengstoffe):

a) Trauzl Block Test. The maximum expansion allowable for permissible explosives was 240 cc for a 10 g sample initiated by a No 8 cap
b) Gap Test (Detonationsübertragung). The minimum acceptable gap was 20 mm when testing cartridges of 35 mm diameter were initiated by No 8 caps. Nearly all permissible explosives had much higher gap values than 20 mm and the sheathed explosives usually gave a value of 300 mm due to the sensitivity of the sheathing which contained about 15% of NG
c) Ability to Transmit Detonation (Detonationsfähigkeit) was determined by the so-called "Four Cartridge Test" (q v)
d) Power of Detonators was formerly determined in a type of ballistic pendulum. Only No 8 detonators were allowed to be used in coal mines. The usual filling for such detonators was 0.75 g tetryl and 0.5 g M F or 0.3 g L A/L St mixture
e) Gallery Tests were conducted with methane-air mixtures and with coal dust.

Reference: BIOS Final Rept 1266 (1947), pp 1-3.

Vinidur. Code name for polyvinyl chloride without plasticizers (CIOS Rept 21-3, pp 5-6 and CIOS Rept 28-62, p 24).

Vinoflex oder Igelit PC. Highly chlorinated (65%) polyvinyl chloride (CIOS Rep 28-62, p 24).

Visol. Trade name for a liquid rocket fuel (Brennstoffe) of variable composition, such as:

a) Vinylethyl ether straight or mixed with some aniline to promote combustion. When used in liquid rocket propellants (such as for Wasserfall) in the proportion of 0.23 parts of Visol per one part of 100% nitric acid, the theoretical specific impulse was 214 lb/lb/sec (Ref 1).

Note: Visol forms with strong nitric acid a hypergolic (self-igniting) combination.

b) Vinyl ether (see Note) 40, iso-propyl alcohol 40, water 2. The remaining 18% consisted of four other ingredients including 1% of a dope to control the ignition delay time (Ref 2).

Note: Vinyl ether of item b) is apparently vinylisobutyl ether, as on the same page of Ref 2 the statement is made that "Visol is a contracted code name for vinylisobutylether"

c) Visol 6 (See next item).

References:
1) Gollin, Rockets and Directed Missiles, CIOS Report 28-56 (1945), p 19
2) Anon, German Explosive Ordnance, TM 9-1985-2 (1953), p 220.

Visol 6. Trade name for Vinylethylether, described in the general section. It was used during WW II as a liquid rocket propelling fuel in guided missiles such as Enzian E-4, Rheintochter R-3 and Wasserfall. Absolute nitric acid was used in these missiles as the oxygen carrier.

References:
1) Anon, Army Ordnance 31, 30 (1946) (Wasserfall)
2) K.W.Gatland, Development of Guided Missiles, N Y (1952), 114-27.

Volpert of Dortmund patented in 1896 and 1897 several mining explosives, such as: a) K nitrate 40, NG 30, collod cotton 1, Mg sulfate cryst 24, turpentine 4, and soda-ash 1%; b) K pyrosulfate ($K_2S_2O_7$) 7.5, Am nitrate 82.5, naphthalene 5.0 and ferrocyanide 5.0%.

Reference: J.Daniel, Dictionnaire des Matières Explosives, Paris (1902), p 789.

VonDahmen Explosives. See Dahmen Explosives and also Dahmenite.

VonStubenrauch Explosives. See Stubenrauch Explosives.

Vorkartusche (Forward Charge). See under Cordite Charge Casings.

Vorlage (Antiflash Bag) (Literally "something put before"). According to Davis, Explosives (1943), p 324, the Vorlage used during WW I consisted of doughnut shaped cotton or artificial silk cloth bags filled with coarsely pulverized K chloride. Two such bags were usually placed in a cannon between the base of the projectile and the propellant charge.

In firing with Vorlage there were produced at the muzzle a red light (glow) and a red smoke. The light gave no reflection in the sky but was visible if the piece was placed in such a way that the enemy could see its muzzle. In the daytime, the Vorlage was used only when the weather was so dark that the flashes of the gun without Vorlage were more visible than the clouds of reddish smoke produced by the Vorlage.

"Vulkan". A fibrous material prepared by hydrating a cellulose with Zn chloride. It was used for self-sealing gasoline tanks.

Reference: CIOS Report 21-3 (1945), p 4.

Wechsender Drall oder Zunehmender Drall. See Progressive Rifling.

Waffen. See Weapons.

Waffenwäger (Weapons Carrier). Several models of armored vehicles designed for carrying field guns were developed during WW II by the firms Krupp, Steyr, Rheinmetall-Borsig, etc.

Reference: CIOS Report 29-20 (1946).

Walsrode (Pulver). A type of sporting propellant manufactured for many years by the Wolff Co at Walsrode in Germany and by the Chilworth Gunpowder Co, Ltd in England. The original propellant was prepd by gelatinizing pure NC with ethyl acetate and adding water (25% of total volume) to the resulting jelly. Then the mixture was kneaded and, while continuing this operation, live steam was introduced. This resulted in the formation of very small grains of gelatinized NC. For removal of volatile solvent, the grains were treated under pressure with boiling water and then dried (Ref 1). The composition of such a propellant, given in Refs 2 and 4 was as follows: NC 98.6 and volatile matter 1.4%; its calorific value was 1014 kcal/kg and volume of gas at NTP 875 l/kg of which 14.8% was nitrogen.

A different composition for Walsrode was given in Ref 3: guncotton 77, Ba nitrate 10, grease 7.0, agar-agar 3.0, glue 2.0 and moisture 1.0%.

References:
1) J.Daniel, Dictionnaire des Matières Explosives, Dunod, Paris (1902), pp 801-2
2) A.Marshall, Explosives, Churchill, London, v 1 (1917) p 327
3) H.Brunswig, Das rauchlose Pulver, W. de Gruyter, Berlin (1926), p 134
4) Thorpe's Dictionary of Applied Chemistry, Longmans Green, London, v 4 (1940), p 530.

Walter Explosives. See Explosives Developed by H. Walter et al.

Walter Submarine. See U-Boot Walter.

Walther Cold Rocket Unit, such as used in the Hecht surface launcher rocket, used hydrogen peroxide/permanganate as the propellant. No details are given.

Reference: K.W.Gatland, Development of the Guided Missile, "Flight", Publication, London (1952), p 117.

Warmlagerversuch (Warm Storage Test), called also Lagerbeständigkeit oder Haltbarkeit (Stability in Storage or Stability) is a test similar to the American Surveillance Test. It was conducted by storing a 10 g sample of a propellant (or an explosive) at a temp of 75° or higher in a closed glass vessel until the appearance of nitrogen oxide fumes. The longer the time required for the appearance of fumes (which might be from several days to several weeks) the more stable was considered the substance under test.

Other Stability Tests are given in the general section

References:
1) Stettbacher, Schiess- und Sprengstoffe (1933), p 201
2) Kast-Metz, Chemische Untersuchung, etc (1944), p 258.

WARPLANTS, ARSENALS, RESEARCH CENTERS, PROVING GROUNDS, etc.

(In collaboration with H.A.Tisch of Picatinny Arsenal)

This review includes both Government and private installations as complete as was possible to obtain from the literature and BIOS, CIOS and PB reports.

War plants were usually constructed in a forest with a minimum removal of trees. Buildings were of permanent and fire-proof construction such as reinforced concrete with one weaker side for blast escape. Quantities of explosives permitted in buildings were usually greater and the interdistances less than permitted by American and British regulations. The floors in the buildings were rather rough, but they were kept clean by frequent sweeping. No overshoes or powder shoes were worn by workers.

In the enclosed alphabetical list are included numerous plants and institutions more or less connected with armament during WW II. Majority of these institutions are closed or are out of existance but many of them can be reopened.

1) Adam and Horn Sprengstoff Fabriken. Plant at Karlsee (Explosives)
1a) Adam Gerhard Motorenwerke, Oskau Friederichsdorf, Sudetengau (Motors)
1b) AEG. See Allgemeine Elektrizitäts Gesellschaft
2) Aerodynamische Versuchsanstalt (AVA), Kaiser Wilhelm Institut, Göttingen (Aerodynamic research). (See CIOS 25-22 and Ref 4a, pp 75 & 131)
3a) A-G. des Altenbergs für Bergbau und Zinkhüttenbetrieb, Essen/Bergeborbeck (Contact and chamber sulfuric acid plants) (BIOS 1639)
3b) Air Force Proving Ground. See Waffenprüfungsstelle der Luftwaffe
3c) Akademie der Luftfahrtforschung (ALF), Berlin. Academy of Aircraft Research (Scientific institution with elective membership). It promoted research in many fields of science (Ref 4a, p 78)
3d) A.Krupp Berndorfer Metallwarenfabrik (Weapons)
4a) ALF. See Akademie der Luftfahrtforschung.
4b) Alfred Krupp, Essen/Borbeck (Steel foundries) (See BIOS Final Rept 716)
5) Allgemeine Elektrizitäts-Gesellschaft (AEG), Berlin (Electrical equipment, cables, rockets, etc)
6) Amag, Hilpert, Pegnitzhütte A-G, Nürnberg (Acid plant equipment)
7) Anschutz & Co, Kiel (Radar, bomb sights, submarine instruments and equipment) (See CIOS 25-39)
8) Anschütz (IG), Zella Mehlis, Thüringen. (Small arms)
9a) Ardelt Werke, Eberswalde/Breslau (Machinery)
9b) Army Proving Grounds. See Waffenprüfungstellen des Heeres
10) Arthur Krupp A-G. See Berndorfer Metallwarenfabrik Arthur Krupp A-G
11) Aschaffenburger Zellstoffwerke A-G, Stockstadt am Main (Wood pulp, utilization of the black liquors from the sulfite boils for the manufacture of ethanol and yeast, various chemicals). (See CIOS 26-34)
12) August Engels, Velbert, Rheinland (Steel foundries) (See BIOS 716)
13a) August Thyssen Hütte A-G, Hamborn (Metallurgy)
13b) AVA. See Aerodynamische Versuchsanstalt
14) Badische Anilin- & Sodafabrik A-G (BASF), Oppau bei Ludwigshafen a/R, Various chemicals including some explosives) (BIOS 1442, p 8)
15) Badische Wolframerz GmbH, Söllingen bei Karlsruhe (Ferro-alloys) (CIOS 30-55)
16) Bamag-Meguin A-G, Berlin (Design and construction of chemical plants (BIOS 1442, pp 110-17)
17a) BASF. See Badische Anilin- & Sodafabrik A-G
17b) Bayerische Maschinenwerke (BMW), bei München, (Research and development of rockets using as fuel hydrazine and some amines and as oxygen carrier concd nitric acid contg about 10% sulfuric acid. The fuel was known as Tonka and the acid as Salbei (See CIOS 28-56, pp 25-26)
18) Bayerische Sprengstoffwerke und Chemische Fabriken A-G, Nürnberg. Plants at Kloster, Lechfeld, Neumarkt and Parsberg (Miscellaneous chemicals and explosives)
19) Bayerische Stickstoff A-G, Piesteritz (Nitric acid) Note: According to BIOS 589 the plant was transferred to Russia
20) Becker & Holländer Waffenbau, Suhl (Small arms)
21) Berckholtz (J.G.W.), Hamburg/Bahrenfeld (Various pyrotechnic items) (BIOS 1233)
22) Bergbau A-G, Lothringen/Blankenburg, Harz (Cast iron and steel projectiles) (CIOS 28-63)
23) Bergbausprengstoff- und Zündmittelwerk, Schönebeck Elbe (Electric blasting caps)
24) Bergische Stahlindustrie, Remscheid (Steel foundries) (BIOS 716)
25) Bergmann Industrie Werke, Abteilung Waffenbau, Suhl und Weltem a/Main (Small arms)
26) Bergwerkgesellschaft Hibernia A-G Stickstoffwerke Wanne-Eickel (Nitric acid) (BIOS 1442, p 29)
27) Berliner-Lübecker Maschinenfabriken (BLM), Lübeck (Small arms and artillery) (CIOS 31-40)
28) Berlin-Suhler Waffen- und Fahrzeugwerke (BSW) Berlin, Suhl und Weimar (Small arms)
29) Berndorfer Metallwarenfabrik Arthur Krupp A-G, Berndorf, Niederdonau (Weapons and ammunition)
30a) Berzelius Metallhütten GmbH, Duisburg/Wanheim (Sulfuric acid) (BIOS 1636)
30b) BLM. See Berliner-Lübecker Maschinenfabriken
31a) BMW. See Bayerische Maschinenwerke
31b) Blumberg & Co, Linnorf bei Düsseldorf (Various pyrotechnic items) (BIOS 1313)
32) Bochumerverein A-G, Bochum, Ruhr with several plants, such as:
 a) Bochum (Metallurgy, centrifugal casting of gun tubes)
 b) Weimar (Metallurgy)
 (See BIOS 716 and CIOS 27-42 and 29-39)
33) Böhmische Waffenfabrik. See Ceskoslovenska Zbrojovka Strakonitz in the Czechoslovakian section
34) Bothe (W), Wolfenbüttel, Heimstättenweg (Blasting machines)
35) Brown-Boveri & Cie A-G Mannheim (Electricity)
36) Brücker & Zinke Zündschnurfabrik, Meissen (Safety fuses)
37) Brück, Schlösser & Co, Osnabrück (Apparatus for testing explosives by the methods of Bichel and Mettegang)
38a) BSW. See Berlin-Suhler Waffen- und Fahrzeugwerke
38b) Buck. See Hans Buck
39) Buderich Werke, Germany (of Gebrüder Böhler A-G, Wien, Austria) (High quality steel) (CIOS 25-14)
40) Buderus Eisenwerke, Wetzlar (Centrifugal casting of gun tubes) (CIOS 29-39)
41) Burberg (Gebrüder) GmbH Maschinenfabrik, Mettmann, bei Düsseldorf (Installations for the manufacture of explosives, propellants and ammunition)
42a) Büscher - Gewehre, Zella Mehlis, Thüringen (Small arms)
42b) Busch - Jäger Lüdenscheider Metallwerke A-G, Lüdenscheid, Westfalen (Ammunition)
43) Büssing - NAG Vereinigte Nutzkraftwagen GmbH, Braunschweig. Several metallurgical plants, which employed during WW II up to 5500 workers nearly half of them foreigners (CIOS 28-46, p 13)
44) Carbonit A-G, Hamburg. Plant at Schlebusch (Explosives)
45) Carl Fleming, Hamburg-Neugraben (Ground and ship pyrotechnic signals). Plant was destroyed
46) Chemische Düngerfabrik, Rendsburg (Sulfuric acid) (BIOS 1642)
47) Chemische Fabrik Kalk GmbH, Köln/Kalk, founded in 1857 (Acids and inorganic chemicals) (BIOS 1442, p 105)
48) Chemische Fabrik Wesseling A-G, Wesseling, bei Köln (Sulfuric acid) (BIOS 1644)
49) Chemische Werke A-G, Thansau (Chemicals and explosives)
50) Chemisch-physikalische Versuchsanstalt (CPVA) der Kriegsmarine, Daenisch Nienhof (Navy physico-chemical research institute) (See CIOS 33-2 and 33-66)
51) Chemisch-technische Reichsanstalt, vormals Militärversuchsamt (Research and development institution for Armed Forces)
52a) Consolidierte Alkaliwerke, Westeregeln (Chemicals and explosives)

52b) CPVA. See Chemisch-technische Versuchsanstalt
53) Daimler Benz Werke, Berlin/Marienfelde (Tanks and other military vehicles) (CIOS 32-33). Plants are located at Untertürkheim, Gaggenau and Mannheim
54) Degussa, Frankfurt a/M. Plant at Hanau a/M (Sintered iron and steel components) (BIOS 595)
55) Demag A-G, Duisburg (Machinery and mechanical equipment) (CIOS 26-77)
56) Dentzdorff Pulverfabrik Kunigunde. Plant at Othfresen (Explosives)
57) Deutsche Cahücitwerke A-G, Gnaschwitz bei Bautzen (Dynamites, permissible explosives, blasting explosives, propellants and fuses)
58) Deutsche Edelstahlwerke A-G, Krefeld (Metallurgy centrifugal casting, etc) (CIOS 24-28, 25-38 and 29-39)
59) Deutsche Eisenwerke A-G Hilden, Rhineland and Mülheim Ruhr (Metallurgy) (BIOS 716 and CIOS 29-39)
60) Deutsche Forschungsanstalt für Segelflug (DFS) Ainring (German Glider Research Station) (Guided missiles) (CIOS 32-66 and Ref 4a, pp 7-11 & 76)
61a) Deutsche Messingwerke C. Eveking A-G, Berlin/Niederschöneweide (Ammunition)
61b) Deutsche Präposit Werke GmbH, Ettlingen (Industrial explosives)
62) Deutsche Pulvermetallurgische Gesellschaft, (DPG) Frankfurt a/Main (Sintered iron and steel ammunition and weapon components)
63a) Deutsche Pyrotechnische Fabriken GmbH. Plants at Cleebronn in Würtemberg; Kieselbach, Kremmen and Neumarkt in Oberpfalz (Various pyrotechnic items) (CIOS 32-38)
63b) Deutsche Röhrenwerke A-G, Mülheim (Weapons and ammunition)
64) Deutsche Sprengchemie GmbH, Berlin/Zehlendorf with plants at:
 a) Dreetz (Propellants)
 b) Forst, Brandenburg (Propellants)
 c) Klietz (Propellants)
 d) Kraiburg (NG, DEGDN, Nipolit, etc)
 e) Moschwig (NC propellants)
 f) Oderburg (Solventless propellants)
 g) Torgelow (Propellants)
65) Deutsche Sprengkapseln Fabrik, Köln (Blasting caps)
66) Deutsche Sprengstoff A-G, Hamburg. Plant at Wahn (Commercial explosives)
67a) Deutsche Versuchsanstalt (DVA) für Kraftfahrzeug und Fahrzeugmotoren, Berlin (Research and development on motor vehicles, motors etc)
67b Deutsche Versuchsanstalt für Luftfahrt (DVL) (German Experimental Establishment for Flying). It was established in 1915 and during WW II there were about 2000 people employed. Its ballistics division at Gatow was led by Schardin (Ref 4a, pp 71, 75 & 79)
68) Deutsche Waffen- und Munitionsfabriken (DWM) A-G, Karlsruhe and Berlin/Borsigwalde (Formerly Berlin-Karlsruhe Industrie Werke). Several plants, such as at Posen and Schültrup bei Lübeck (Various weapons and ammunition). Research was conducted at the Forschungsanstalt, Lübeck (See CIOS Reports 30-71 and 33-20)
69) Deutsche Werke A-G Erfurt (Small arms)
70a) Deutsches Zündwaren Monopolgesellschaft, Berlin (Ignition and initiation devices). Also at Lüneburg (Pyrotechnic items) (BIOS Final Rept 1313)
70b) DFS. See Deutsche Forschungsanstalt für Segelflug
71) DHZ Chemie-Abteilung Sprengstoffe, Berlin (Explosives, primers, initiators, safety fuses, sporting ammunition, pyrotechnic devices, etc)
72) Dornheim (G.C.) A-G, Suhl (Small arms)
73a) Dortmund-Derne Testing Gallery. See Versuchsstrecke Dortmund/Derne
73b) DPG. See Deutsche Pulvermetallurgische Gesellschaft
74a) Draghan. See Fabrik Draghan
74b) Draht- und Metallwarenfabrik, GmbH, Salzwedel. (Ammunition)
75a) Dr Alexander Wacker Gesellschaft für Elektrochemische Industrie, Burghausen (Chemicals from acetylene) (CIOS 25-20)
75b) Dresdner Dynamit Fabrik, Dresden. Plant at Muldenhütten (Commercial explosives)
76a) DVA. See Deutsche Versuchsanstalt für Kraftfahrzeug
76b) DVL. See Deutsche Versuchsanstalt für Luftfahrt
76c) DWM. See Deutsche Waffen- und Munitionsfabriken A-G
77) Dynamit Aktiengesellschaft (D A-G or DAG) vormals Alfred Nobel & Co. Head office at Troisdorf, Bez Köln with plants at:
 a) Adolzfurth, bei Heilbronn (Black powder) (CIOS 32-38)
 b) Bergensdorf (Industrial explosives)
 c) Böhlitz-Ehrenberg, bei Leipzig (Glycerin and other chemicals) (CIOS 32-38)
 d) Draghan, Danneberg (TNT, industrial explosives, ammunition loading, safety fuses, etc)
 e) Düneberg a/d Elbe, bei Geesthacht, Bez Hamburg, founded in 1880. During WW II the plant occupied an area of 1.8 sq-miles and employed up to 8000 workers, many of them foreigners. The personnel of the plant developed (in collaboration with General Uto Gallwitz) various "cool" propellants. (See G Pulver and Gudolpulver).
 Most of these new propellants were manufd at Düneberg
 No acids, NC, NG nor DEGDN were manufd at Düneberg. The NC-NG or NC-DEGDN mixtures were received from the Krümmel plant in the form of Rohpulvermasse and blended at Düneberg by passing through hot rolls
 (See CIOS Reports 28-61, 29-24 & 31-68 and PB Rept 925)
 f) Empelde, bei Hannover (Ammunition for Flak, Pak and infantry) (CIOS 32-38)
 g) Förde an der Lenne, Grevenbrück, Westfalen (Safety fuses, blasting caps and detonators) (CIOS 32-38)
 h) Hamm a/d Sieg (Black powder) (CIOS 32-38)
 i) Hasloch, Baden (Propellants and cartridges for small arms)
 j) Kaufbeuren bei Landsberg/Lech (NC propellants, blasting caps, detonators and ammunition loading)
Note: According to CIOS Repts 29-28 and 32-38, the Kaufbeuren plant belonged to the Dynamit-A-G Subsidiary
 k) Krümmel Post Geesthacht, Bez Hamburg, founded in 1865 by A.Nobel and then enlarged during both WW's. During WW II it occupied 1.6 sq miles and employed up to 9000 workers, many of them foreigners
 Work at this plant included some ammunition loading and the production of TNT, PETN, NC, NG, DEGDN, TEGDN, RDX, metriol trinitrate, industrial explosives, plastics, nitric acid, sulfuric acid and Rohpulvermasse. The last item was shipped to the Düneberg plant for manufacture of POL (solventless propellant)
 The RDX branch of Krümmel plant was damaged in 1943 and production of RDX was stopped
 (See CIOS Repts 28-61 & 29-24 and PB Rept 925)
 l) Nürnberg (Steel case small arms ammunition, hunting and sporting ammo and pyrotechnic items) (CIOS 27-36 and 32-38)
 m) Reichsweiler, Elsass (Small arms ammunition)
 n) Rottweil, Schwarzwald, founded in 1872 as a black powder factory, was changed over, prior to WW I, to single-base propellants. The plant was considerably expanded in 1939 and manufd large amounts of small arms propellants
Note: This plant seems to be identical with the Troisdorf A-G plant described in CIOS Rept 26-70
 o) Saarwellingen, Kr Saarlautern (Industrial explosives) (CIOS 32-38)
 p) Schlebusch, Leverkusen, bei Köln (TNT, NC, NG, PETN, P A, M F, L A, oleum and industrial explosives) (CIOS Repts 24-4, 29-24 and 32-38)
 r) Stadeln (Steel case small arms ammo, L A, L St, detonators, hunting and sporting ammunition) (CIOS 27-36 and 32-38)

a) Troisdorf, Bez Köln, parent plant of D A-G constructed at the end of the 19th century, was considerably expanded before WW II. At the peak of production it employed up to 10,800 workers of whom 2,000 were foreigners. The plant was severely damaged in 1944 and 1945 by bombs. Following items were manufd during WW II: NC, PETN, tetryl, azides, blasting explosives, permissible explosives, initiating compositions, delay and electric detonators, propellants, fuses and fuzes (See BIOS Final Rept 644 and CIOS Rept 24-3 and 32-38)
t) Würgendorf, Burbach, Kr Siegen (Industrial explosives) (CIOS 32-38)

78) Dynamit A-G Subsidiary, called GmbH zur Verwertung chemischer Erzeugnisse, formed in 1945 by combining the resources of Dynamit A-G with those of OKH (Oberkommando Heereswaffenamt), had the following plants:
a) Allendorf, bei Kirchhain, Kreis Marburg, Lahn (TNT, sulfuric anhydride from spent sulfuric acid and ammunition loading) (CIOS 32-38)
b) Aschau, bei Mühldorf a/Inn, Obb (Nitrocellulose) (CIOS 32-38)
c) Bobingen, bei Augsburg (Hexogen by KA process). (Fairly detailed description is given in CIOS Rept 32-8)
d) Bromberg, Westpreussen (DNB, TNT, NC, NG, DEGDN, solventless propellants, ammunition loading, oleum from spent sulfuric acid, etc) (CIOS 32-38)
e) Christianstadt am Bober, covered during WW II about 6½ sq miles and employed about 7000 workers many of whom were foreigners (Formaldehyde, Hexogen, NC, NGu, Man-Salz, Myrol, Tetra-Salz and loading of bombs and small caliber shells) (See CIOS Rept 32-38)

Note: CIOS Rept 28-61 lists this plant as belonging to the Dynamit A-G

f) Clausthal-Zellerfeld, Harz was heavily damaged in 1944 (TNT and shell loading)
g) Döberitz a/d Havel, Westhavelland (Hexogen, hexamine and NGu)
h) Dömitz, a/d Elbe (Picric acid, TNT, propellants and ammunition loading)
i) Ebenhausen, bei Ingolstadt und München, constructed in 1914, was destroyed in 1945 except for the propellent section. It manufd NC and solvent propellants (CIOS 32-38)
j) Glowen, Westpriegnitz/Havel, originally designed as a NC plant, was manufacturing during WW II some initiating items. Was severly damaged in 1945 (CIOS 32-38)
k) Grünberg, Schlesien (Detonators) (CIOS 32-38)
l) Güsen, Bez Magdeburg (NC, TNT and loading of bombs and shells) (CIOS 32-38)
m) Hertine, bei Töplitz/Schönau (Loading of bombs and mines) (CIOS 32-38)
n) Herzberg, Südharz (Loading of bombs and mines). Was completely destroyed by bombs in 1945 (CIOS 32-38)
o) Hessisch-Lichtenau, Bez Kassel (Picric acid, TNT, oleum from spent sulfuric acid and loading of bombs and shells) (CIOS 32-38)

Note: It also operated a plant at Eschenstruth.

p) Hohensaaten at Neudorf a/d Oder, Mark-Brandenburg (NC, NG and experimental station)
r) Kaufbeuren. See item (j) under Dynamit A-G
s) Kaufering, bei Augsburg/Land (NC and mortar shell cartridges)
t) Kuchzina, bei Ratibor (Loading of small bombs and shells) (CIOS 32-38)
u) Ludwigsdorf, Kr Glatz (Press-loading of ammunition) (CIOS 32-38)
v) Malchow, bei Waren, Mecklenburg (PETN, trinitroresorcin, blasting caps, detonating fuse, etc) (CIOS 32-38)
w) Malmitz, Kr Sprotau, Schlesien (Loading of small bombs and shells) (CIOS 32-38)
x) München, Bayern (Fuzes, such as Uhrwerkzünder for Flak 8.8 cm Was severely damaged in 1943, 1944 and 1945 by bombs.
y) Petersdorf Schlesien (Loading of small bombs and shells) (CIOS 32-38)
z$_1$) Premnitz a/d Oder (Ammunition loading)
z$_2$) Uckermünde, bei Stettin, Pommern (NC, NGu, ammunition loading and experimental station)
z$_3$) Wolfratshausen, bei München, Bayern (L A, L St, tetracene, PETN, blasting caps, detonators and loading of some small caliber shells)

79a) Eckert & Ziegler GmbH, Köln-Braunfeld (Explosives) (CIOS Rept 32-38)
79b) Egellander Stahlindustrie, Rothau (Centrifugal casting of gun tubes) (CIOS Rept 29-39)
79c) Eibia GmbH, Beneteld bei Bömlitz (NG by continuous method, explosive compositions and propellants)
79d) Eichhorn (Karl) Waffenfabrik, Solingen (Small arms)
80a) Eisenacher Karosseriefabrik Assmann GmbH, Eisenach (Weapons)
80b) Eisen- und Hüttenwerke Bochum, Ruhr (Metallurgy)
80c) Eisenwerke A-G, Kaiserslautern (Metallurgy)
81) Eisenwerke Oberdonau. See in Austrian section
82) Eisfeld (J.F.) Pulver- und Pyrotechnische Fabriken GmbH, Plan at Silberhütte, Anhalt, founded in 1790, manufd black powder and various pyrotechnic items, while plant at Kunigunde manufd only black powder (CIOS 32-38)
83) Elektrochemische Werke, Höllriegelskreuth (Hydrogen peroxide) (CIOS 25-44)
84) Elektromechanische Werke, Peenemünde with branches at Anklam, Kummersdorf, Bodensee (Lake Constance) and Bleicherode, Harz (Rockets and guided missiles using liquid propellants)
85) Elektro-Nitrum A-G, Rhina, bei Kleinlaufenburg, Baden (Nitric acid) (BIOS 1442, p 48)
86a) Elektro Schmelzwerke A-G, Kempten, Allgäu, Bayern (Metallurgy) (CIOS 26-35)
86b) Embsen Fabrik. See under IG Farbenindustrie
87) Erfurter Laden Industrie, Erfurt, Nord (Ammunition)
88) "Erma". See Geipel (B) GmbH
89) Ernest Brünn GmbH Zünderwerke, Krefeld/Linn (Equipment for electrical priming and initiation, such as the "Untertag" blasting machines,
90) "E" Stelle, Travemünde (Air Forces research center and experimental station)
91) Eumuco A-G, Leverkusen - Schlebusch (Designers, manufacturers and users of "Eumuco" shell forging press) (BIOS 668)
92) Fabrik Aschau. See item (b) under Dynamit A-G Subsidiary
93) Fabrik Dragahn der Wasag - Commissions A-G a/d Elbe, bei Dannenberg (TNT, detonating fuse and filling some hand grenades) (CIOS 32-38)
94) Fabrik Elektrischer Zünder GmbH, Köln (Electric igniters, detonators and exploders)
95a) Felten, Guilleaume & Co, Köln/Kalk (Electrical equipment, cables)
95b) FEP. See Forschungsentwicklung Patente
96a) Ferdinand Wicke, Wuppertal - Barmen (Pyrotechnic items including amorces (BIOS Final Rept 1313)
96b) FFA. See Flugfunkforschungsanstalt
96c) FGZ. See Forschungsanstalt Graf Zeppelin
96d) Firmeninstitute were institutions of commercial firms engaged in research and development of ammunition, weapons, aircraft, tanks etc. The principal firms were: Krupp, Rheinmetall-Borsig, DWM-Mauser, WASAG, Bergmann and Gustloff Werke (Ref 4a, pp 77-8 & 82)
96e) FKFS. See Forschungsinstitut für Kraftfahrzeuge
96f) Flugfunkforschungsanstalt (FFA), Oberpfaffenhofen, Bayern. Electrical research institute for high frequency (Radio control for guided missiles, radar, etc) (Ref 4a, p 76)
97a) FoFü. See Forschungsführung
97b) FOGEVA. Forschungsgesellschaft für Verfahrensausbau, Birkigt bei Bodenbach a/Elbe (Myrol e, Tetranit, monopropellant rockets)
97c) Forschungsanstalt Graf Zeppelin (FGZ) Stuttgart/Ruit (Flight research institute)

Note: This institute, also called LGZ (Luftforschungsanstalt Graf Zeppelin, is described in Ref 4a, 24-33 & 76

97d) Forschungsentwicklung Patente, Berlin. Navy institution engaged in research and development of patents suitable for military application (Ref 4, p 86)
97e) Forschungsführung (FoFü), Berlin, (Research Directorate) was a unit governing all research and development organizations relative to the Air Force (Ref 4a, pp 71 & 73-5)
97f) Forschungsinstitut für Kraftfahrzeuge und Flugmotoren, Stuttgart-Untertürkheim (FKFS). Institute for Automobile and Aircraft Motors (Research and development of various types of engines including the closed-cycle type Daimler-Benz U-boat Diesel) (CIOS Rept 30-76, p 3 and Ref 4a, p 76)
98) Franz Stock Maschinen- und Werkzeugfabriken, Berlin (Machinery and weapons)
99) Friedrich - Alfred Hütte, Rheinhausen (Metallurgy) (CIOS 24-16)
100) Friedrich Krupp A-G, Essen, Ruhr. One of the world's largest organizations manufacturing guns, tanks, U-boats and other war items. Numerous plants, among them the following:
a) Blankenburg (Metallurgy)
b) Bremen (Steel works)
c) Capito und Klein Werke, Düsseldorf/Benrath (Rolling mills)
d) Essen (Home plant) (Steel works and forging)
e) Grusonwerk, Magdeburg-Buckau (Tanks)
f) Kiel (Shipbuilding, U-boats)
g) Meppen (Proving ground)
(See CIOS Repts 28-64, 28-66 and 30-93)
101) Fritz Kiess & Co, GmbH Waffenfabrik, Suhl (Weapons)
102) Fritz Wolf Gewehrfabrik, Zella Mehlis, Thüringen (Weapons)
103) Funk & Co, Suhl (Weapons)
104a) Gaswerke, Frankfurt a/M (Sulfuric acid) (BIOS 1645)
104b) Geba, Metallwarenfabrik, Breslau (Metallurgy)
105) Gebrüder Behler, Buderich/Hurdt, bei Düsseldorf (Steel forging) (CIOS 26-69)
106a) Geipel (B) GmbH Waffenfabrik "Erma", Erfurt (Weapons)
106b) Genschow. See Gustav Genschow
107) Georg von Gieschens' Erben, Magdeburg (Zinc mining and smelting, alloys, sulfuric acid) (CIOS 31-56)
108) Gewehrfabrik H. Burgmüller & Söhne GmbH, Kreiensen, Harz (Weapons)
109) Gewerkschaft Victor Chemische Werke, Castrop-Rauxel, Westfalen (Nitric acid, Am nitrate, synthetic fuels by Fischer - Tropsch process, etc)
110) GmbH zur Verwertung chemischer Erzeugnisse. See Dynamit A-G Subsidiary
111a) Golzern - Grimma Maschinenbau A-G, Grimma bei Leipzig (Machinery for manuf of explosives, propellants and acids)
111b) Gottow Proving Ground was a station for testing explosives, guns and rockets (Ref 4a, p 85)
112a) Graf Zeppelin Flight Research Institute. See Forschungsanstalt Graf Zeppelin
112b) Grossfuss, Johannes. See Johannes Grossfuss
113) Guss-stahlwerke Wittmann, Hagen/Haspe (Steel foundry) (BIOS 716)
114) Gustav Genschow & Co, A-G, Berlin. Plants at Berlin, Durlach, Hachenburg and Wolfartsweier bei Durlach (Hunting and sporting ammunition, rifle and pistol ammunition and leather articles) (CIOS 32-38)
115) Gustloff Werke at Meiningen, Suhl and Weimar (Weapons)
116) Gutehoffnungshütte A-G (vorm Haniel & Lueg), Düsseldorf, Grafenburg and Sterkrade (Steel foundry and shell forging (BIOS Repts 668 and 716)
117) Hackethal Draht- und Kabelwerke A-G, Hannover (Wires, cables, etc) (CIOS 25-32)
118) Hänel (C.G) Waffen- und Fahrrad Fabrik, Suhl (Small arms)
119) Hans Boas Nachfolger, Berlin (Apparatus for ballistic measurements)
120) Hans Buck, Geradstetten (Pyrotechnic items) (BIOS Final Rept 1233)
121) Hanseatische Apparatbaugesellschaft, Kiel (Apparatus, instruments, ammunition loading)
122) Hasenclever A-G, Düsseldorf (Shell forging using "Eumuco" press)
123) Hechtenberg, (H) Maschinenfabrik, Düren, Rheinland (Installations for plants manufacturing explosives, ammunition and weapons)
124a) Heereswaffenamt (HWA) (Army Weapons Office)

Berlin, organized before WW I under famous ballistician Carl Cranz, was in charge of production, procurement, testing and development of all Army weapons. During WW II it became part of the Ministerium Speer (q v) (Ministry of Armaments and War Production) named after its head. The following organizations were under HWA jurisdiction: Waffenamt Prüfwesen, Waffenforschung, Firmeninstitute, Hochschulinstitute and Waffenprüfungsstellen.
124b) Heeres Zeugamt, Ingolstadt (Armed Forces Ordnance Office)
125) Heinrich Krieghoff Waffenfabrik, Suhl (Weapons, among them Luger - Parabellums and machine gun FG-42)
126a) Heinrich Reining GmbH, Enger, Westfalen (Metallurgy, ammunition, chrome-plating of gun barrels, etc) (CIOS 32-64)
126b) Henckels Zwillingswerk, J.S. Schneid, Solingen (Ammunition)
127) Henschel und Sohn, Kassel transferred in 1943 to Hannover-Munden (Locomotives, trucks, and tanks) (CIOS 28-46, p 18)
128) Herdersche (V) Pulverfabrik, Forchheim (Explosives and propellants)
129) Hermann Göring Aeronautical Research Institution. See Luftfahrtforschungsanstalt
130) Hermann Göring Organization controlled several plants, such as:
a) Paul Pleigerhütte und Stahlwerke, Braunschweig (Steel works and weapons)
b) Salzgitter (Minerals and metals)
c) Wettenstedt (Shells)
(See CIOS Repts 26-86, 29-30 & 30-84)
131a) Hermann Orth, Ludwigshafen/Oggersheim, Pfalz (Mixing and kneading devices for explosives plants)
131b) Hersteller Weihrauch, Zella Mehlis (HWZ) (Weapons)
132a) Hillersleben Proving Ground was one of the Army's weapon testing stations (Waffenprüfungsstellen des Heeres). It tested artillery weapons in connection with development work (Ref 4a, pp 84 & 130).

Note: According to CIOS Rept 31-72 (1945), the small arms research section of Kummersdorf was transferred to Hillersleben in March 1945

132b) Hirsch Kupfer- und Messingwerk A-G. Finow/Mark (Ammunition)
133a) Hochfrequenz Tiegelstahl, Bochum, Ruhr (Steel foundry centrifugal casting etc) (BIOS Final Rept 716 and CIOS Repts 29-39 & 31-46)
133b) Hochschulinstitute (Institutes affiliated with technical colleges). These consisting of 200 establishments (as well as their governing body of twelve technical colleges) did research and development work for the Armed Forces. The technical colleges were located at: Berlin, Aachen, Braunschweig, Danzig, München, Karlsruhe, Wien, Dresden, Darmstadt, Graz, Hannover and Stuttgart (Ref 4a, pp 78, 82 & 85) (See also Reichsforschungsrat)
134) Holler (F.W.) Waffenfabrik, Solingen (Weapons)
135) Hösch A-G, Dortmund (Metallurgy, armor plates, projectile cases, steel cartridge cases and research) (CIOS 28-46 & 29-17)
136a) Hugo Schneider A-G, Taucha-Leipzig (Metallurgy, copper, brass, aluminum, steel cartridge cases) (CIOS Repts 31-54 & 31-57). At Altenberg (Ammunition)
136b) HWA. See Heereswaffenamt
136c) HWZ. See Hersteller Weihrauch
137) I G Farbenindustrie A-G, Ludwigshafen, with numerous plants, among them:
a) Bitterfeld - Süd (Nitric acid)
b) Elberfeld (Various chemicals)
c) Embsen, Kr Lüneburg (Nitric acid)
d) Frankfurt a/Main (Fuels, lubricants and weapons)
e) Herne - Solingen, (Ruhr), vorm "GAVEG" (Nitric acid)
f) Höchst a/Main (Nitric acid and other chemicals)
g) Leverkusen bei Köln (Acids and chemicals)
h) Lothringen Werke, Bochum - Gerthe (Nitric acid)
i) Mainkur Werke, Fechenheim (Various chemicals)
j) Oppau Werke, Ludwigshafen (Metallurgy and intermediates for explosives)
k) Wolfenfarbenfabrik bei Halle (Various chemicals,

among them dyes used in colored smokes
(See BIOS Final Repts 1232, 1442, 1633 and CIOS Repts 22-16, 23-15, 24-12, 24-21, 24-28, 24-31, 25-45, 26-2, 27-14, 27-85 & 29-14)

Note: According to BIOS Rept 1442, the I G Farbenindustrie was liquidated by the Allied Control Commission

138) Institut für physikalische Forschung, Neu Drossenfeld (Physical research, development of guided missiles) (CIOS 28-41)
139) Jäger (F) & Co, Suhl (Small arms)
140) Johannes Grossfuss, Metall- und Lackierwarenfabrik, Döbeln, Sachsen (Weapons)
141a) Josef Meissner, Köln Bayenthal (Machinery for plants manufacturing propellants, explosives and ammunition, spec apparatus for continuous methods of manuf of liquid explosives such as NG, NGc, DEGDN, etc)
141b) Kabel- und Metallwerke Neumeyer A-G, Nürnberg (Ammunition)
141c) Kaiser-Wilhelm Institut, Berlin. Emperor William Institute (Nuclear physics to develop atomic energy as a weapon (Ref 4a, p 78)

Note: This institute existed in several branches as at Göttingen (See AVA) and Clausthal-Zellerfeld (See next item)

142a) Kaiser Wilhelm Institut für Eisenforschung, Clausthal-Zellerfeld (evacuated from Düsseldorf in Sept 1943) (Ferrous metallurgy research). Its branch at Urach near Stuttgart was engaged in non-ferrous metallurgy research (CIOS 28-46, p 17)
142b) Karl Eichhorn Waffenfabrik. See Eichhorn (Karl)
143) Karl Fischer Apparate- und Rohrleitungsbau, Berlin (Installations for plants manufacturing nitrotoluenes, formaldehyde, hexamethylenetetramine, RDX, etc)
144a) Karl Walther, Zella Mehlis, Thüringen (Small arms)
144b) Karl Zeiss. See Zeiss (Karl)
145) Kieselchemie GmbH, Kieselbach, Harz (Compressed items from black powder) (CIOS 32-38)
146) Kieserling & Albrecht A-G, Solingen (Shell forging using "Eumuco" press) (BIOS 668)
147) Klein, Schanzlin & Becker A-G, Frankenthal, Pfalz (Equipment for armored fighting vehicles) (CIOS 26-66)
148) Klocknerwerke A-G, Castrop/Rauxel (Fuels and lubricants by Fischer-Tropsch process) (CIOS 25-7)
149) Klocknerwerke A-G, Hagen/Haspe, with several plants) (Metallurgy) (CIOS 29-61)
150) Knorr-Bremse GmbH, Hagen/Egge (Steel foundry, weapons) (BIOS Final Rept 716)
151) Kochelsee, Bayern. See Wasserbau-Versuchsanstalt
152) Kohle und Eisen Forschungsinstitut, Dortmund (Research on coal and steel)
153a) Köln - Rottweil A-G, Berlin. Plants at Hamm, Heliethal, Rheinsdorf and Ronsahl (Military explosives and propellants)
153b) Kommandit Gesellschaft Walter, Kiel. See Walter Werke, Kiel
154a) Kontinitro A-G, Vaduz, Liechtenstein (Installations for continuous nitration of liquids such as glycerin, ethyleneglycol, diethyleneglycol, etc by method of Schmid)
154b) Kp or Kr. See Friedrich Krupp A-G
155) Krieghoff Waffenfabrik, Suhl (Weapons)
156) Kronprinz A-G, Immigrath (Shell forging using "Eumuco" press)
157) Krupp. See Alfred Krupp, Arthur Krupp and Friedrich Krupp
158a) Kummersdorf Proving Ground, near Berlin, was the main army testing station for explosives, ammunition, artillery weapons and rockets (See also Kummersdorf West). Full scale range was maintained at Kummersdorf and there were 15 experimental areas for different types of tests. The station was also provided with its own power units and well-equipped machine shops, welding shops and tool shops (Ref 4a, pp 84 & 130-1)

Note: According to CIOS Rept 31-72 (1945), p 3, some research and development of small arms was conducted at Kummersdorf until these activities were transferred to Hillersleben in 1945 on account of bombings

158b) Kummersdorf West (Army Weapons Department Experimental Station), located 17 miles south of Berlin in the province of Brandenburg, was established about 1930 as a solid-propellant rocket development center. It was expanded about 1932 to include the development and testing of liquid-propellant rockets. The first successful liquid-propellant rocket, designated as A-1 (Aggregat Eins), was developed at Kummersdorf West under General Walter Dornberger. The second rocket, A-2, 4.5 calibers long, was constructed in 1934 and after this it became evident that a larger area than that at Kummersdorf West was required for development and testing of liquid-propellant rockets. It was then decided to construct another rocket center at Peenemünde (q v)

Reference: W. Dornberger, V-2, Viking Press, N Y, (1954), pp 23-41

159a) Kupfer- und Messingwerke K.G. Becken & Co Langenberg/Rheinland (Ammunition)
159b) Kupferwerk Ilsenburg A-G, Harz (Ammunition)
159c) Land- und Seekabelwerke, Köln (Cables and various chemicals) (CIOS 25-33)
160a) Langbein - Pfanhauser Werke A-G, Leipzig (Steel cartridge cases) (CIOS 31-53)
160b) LFA. See Luftfahrtforschungsanstalt Hermann Göring
160c) LFM. See Luftfahrtforschungsanstalt München
160d) LGZ (Luftfahrtforschungsanstalt Graf Zeppelin). See Forschungsanstalt Graf Zeppelin
161a) Lignose Sprengstoffwerke GmbH with plants at:
a) Krüppamühle, Oberschlesien (Industrial explosives and blasting caps)
b) Reichenstein, Schlesien (Safety fuses)
c) Schönebeck a/d Elbe, Magdeburg (TNT, PETN, initiating explosives and compositions, detonators, shotgun propellants, ammunition loading, etc
161b) Lilienthal Gesellschaft. A society (named after the first man to fly a glider) interested in air force research (Ref 4a, pp 78-9)
162) Lindener Zündhütchen- und Patronenfabrik A-G, Troisdorf. (Priming devices and cartridges)
163a) Luftfahrtforschungsanstalt (LFA) Hermann Göring E.V., Volkenrode, Braunschweig (Aeronautical research institution; developed some rockets, guided missiles, rocket fuels, etc) (CIOS 29-45)

Note: According to L.E. Simon (Ref 4a, pp 12-24 & 75), the LFA occupied an area 2½ square miles and employed about 1200 people. It was engaged in research and development of weapons, motors, airplane structures and acoustic fuzes. There was also an aerodynamic research institute, a theoretical ballistics institute and a large range for firing the weapons

163b) Luftfahrtforschungsanstalt München (LFM), was an Air Force research institution founded in 1942 but not completed. It included an institute for air medicine and employed about 200. Similar institutes were established at the end of the war in Heidelberg and Wien (Vienna) (Ref 4a, p 75)
164) Luftwaffe Research Institute, Bad Blankenburg (Radar, rocket fuels, lubricants, metallurgy, etc) (CIOS 28-39)
165) Luftwaffe Testing Station. See Rechlin Testing Station
166) Lurgi Chemie, Frankfurt a/Main (Design of sulfuric acid plants) (BIOS 1631)
167a) Mahle (KG), Bad Cannstatt, Stuttgart (Metallurgy) (CIOS 26-84)
167b) Maibach Motorenwerke. See Zeppelin GmbH
168) Mako & Vakuumtrockner GmbH, Erfurt, Thüringen (Machinery for plants manufacturing explosives and propellants)
169) Mannesmann Röhrenwerke, Duisburg/Huckingen (Metallurgy) (BIOS 595, p 52)
170) MAN. See Maschinenfabrik Augsburg-Nürnberg
171) MAN. Research Laboratory, Augsburg (Research and development of engines) (CIOS 33-2)
172) Mansfeld A-G, Kupfer- und Messingwerke, Hettstadt, Thüringen (Copper and brass metallurgy) (CIOS 29-18). At Rothenburg/Saale (Ammunition)
173) Mansfeldscher Kupferschieferbergbau A-G, Eisleben (Copper and other non-ferrous metals) (CIOS 31-55)
174) Maschinenfabrik Augsburg-Nürnberg (MAN) (Weapons and armored vehicles)
175) Maschinenfabrik Gustav Eirich, Hardheim, Nordbaden (Mixing devices for use in explosives and propellants plants)

176a) Maschinenfabrik Niedersachsen (MNH) GmbH, Hannover (Armored vehicles)
176b) Maschinenfabrik Peterson, Oldenburg Holstein (Bombs, fuzes, pyrotechnic items, weapons and chemical warfare agents) (CIOS 32-13)
177) Maschinen für Massenverpackung GmbH, Schültrup bei Lübeck (Machinery and weapons) (CIOS 26-72)
178) Matter (O), Köln/Marienburg (Machinery for manuf of explosives, propellants and ammunition)
179) Mauser Werke A-G (Waffenfabrik Mauser), Oberndorf a/Neckar, with plants manufacturing various weapons located at:
a) Berlin/Borsigwalde (Spandau plant)
b) Karlsruhe
c) Köln/Ehrenfeld
d) Oberndorf
e) Waldeck, Bez Kassel
180) Meissner. See Josef Meissner
181a) Meppen Proving Ground. See Waffenprüfungsstelle der Kriegsmarine
181b) Merz-Werke, Gebr Merz, Frankfurt a/Main (Weapons)
182a) Metallgesellschaft, Rockenheimer Anlage, Frankfurt a/Main (Sintered iron and steel components) (BIOS Final Rept 595)
182b) Metall-, Walz- und Plattierwarenfabrik, Hendricks-Auffermann A-G, Oberbarmen Wuppertal (Ammunition)
182c) Metallwarenfabrik Treuenbritzen GmbH at Sebandushof and Selterhof (Ammunition)
182d) Metallwarenfabrik, vorm H. Wessmer A-G, Brotterode/Hessen (Ammunition)
182e) Metallwerke Fa Lange A-G at Aue/Sa [illegible] Bodenbach, Sud (Ammunition)
182f) Metallwerke Silberhütte, St Andreasberg (Ammunition)
182g) Metallwerk Treuenbritzen at Belzig and Röderhof (Ammunition)
182h) Metallwerk Wandhofen, Schwerte (Ammunition)
183a) MIAG. See Mühlenbau und Industrie A-G
183b) Miedziankit GmbH, Obernhof a/d Lahn (Industrial explosives)
183c) Ministerium Speer. Ministry, named after its chief, was in charge of all German WW II production, allocation of all materials and allocation of all priorities. It exerted control over the Ordnance Department of the Army (Heereswaffenamt) and of the Navy [Marine (Kriegsmarine) Waffenamt] but it is not clear what relations it had with the Air Force (Luftwaffe), except that the Ministerium Speer was under partial control of Reichsmarschall Göring, the head of the Air Force (Ref 4a, p 68, 71 & 86). The Ministerium Speer exerted a considerable control over almost every government agency and toward the end of the war the Ministerium entered the management and prosecution of research. It established several research and development institutes of its own
184) Mitteldeutsche Sprengstoffwerke Miedziankit GmbH, Goslar Plant at Langelsheim (Industrial explosives)
185) MNH. See Maschinenfabrik Niedersachsen GmbH, Hannover
186) Möller & Schulze, Magdeburg (Machinery for chemical and explosives industry)
187) Mühlenbau und Industrie A-G (MIAG), Braunschweig, with several plants (Metallurgy, tanks, tank destroyers, trucks, etc) (CIOS 28-46)
188) Munitionsanstalt Cassel (Ammunition loading factory)
189) Munitionsanstalt Hannover (Ammunition loading factory)
190) Munitionsanstalt Ingolstadt (Ammunition loading factory)
191) Munitionsanstalt Jüterbog (Ammunition loading factory)
192) Munitionsanstalt Königsberg (Ammunition loading factory)
193) Munitionsanstalt Stettin (Ammunition loading factory)
194) Munitionsanstalt Zeithai (Ammunition loading factory)
195a) Nachrichten Versuchsanstalt (NVA), was an establishment developing and testing Naval radio devices (Ref 4a, p 86)
195b) Navy Proving Ground. See Waffenprüfungsstelle der Kriegsmarine
195c) Neufeldt und Kuhnke, Kiel (Ammunition loading)
196a) Nibelungenwerke. See Austrian section
196b) Niebecker und Schumacher, Iserlohn, Westfalen (Ammunition)
197a) Norddeutsche Affinerie, Hamburg (Sulfuric acid by contact and Petersen tower methods) (BIOS 1641)
197b) Norddeutsche Maschinenfabrik, Berlin (Weapons)
198a) Norddeutsche Sprengstoffwerke A-G, Hamburg, Plant at Quickborn (Explosives)
198b) NVA. See Nachrichten Versuchsanstalt
199) Opel A-G (Subsidiary of General Motors), Plant at Rüsselsheim, near Frankfurt a/M (Motor-vehicles)
200a) Oskar Fischer Fabrik, Markdorf bei Bodensee (Lake Constance) (Pyrotechnic items)
200b) Osnabrücker Kupfer- und Drahtwerke, Osnabrück (Ammunition)
201) Patronen-, Zündhütchen- und Metallwaren- Fabrik (Vormals Sellier & Bellot), Schönebeck and Bad Salzelmen bei Magdeburg, founded in 1829 by the chemist N. Bellot. (Blasting caps, detonators; pistol, revolver, sporting and hunting ammunition)
[See Anon, S S 24, 271 (1929) and CIOS 32-38]
202) Peenemünde (Army Rocket Experimental Station), located on the Baltic coast, near the Peene estuary and southeast of Rügen island, was established about 1937 as a liquid-propellant rocket development center with General Walther Dornberger in charge.
The following rockets were developed and tested at Peenemünde:
a) A-3 (unsuccessfully launched in 1937)
b) A-5 (successfully launched in 1939 after several previous failures)

Note: These two were experimental models.
c) A-4 known now as V-2 (Vergeltungswaffe Zwei, Revenge Weapon 2) was successfully launched in October 1942 after some earlier failures. Its production started in the middle of 1943
d) A-9 was the winged version of A-4
e) A-9/A-10 was a two-step rocket which was designed to span the distance from Europe to the U S A in 40 minutes.
f) - A-10,
For more information about the activities at Peenemünde before and during WW II, see:
L.E. Simon, German Research in World War II, J. Wiley, N Y, (1947), and
W. Dornberger, V-2, Viking Press (1954) pp 42-63, 76, 80, 93-8, 142-3, 239 and 250

Note: Greifswalder Oie, mentioned in Dornberger's book, is a small narrow island located north of Usedom island and near the Peene estuary. The island belonged to the Peenemünde rocket center and was used for firing rockets smaller than the A-4 (such as the A-3 and A-5)

According to L.E. Simon (Ref 4a, pp 33 & 84), the total cost of construction and equipment of Peenemünde Center was about 300 million Reichsmarks and at the height of activity the Peenemünde employed 2200 scientists and technicians, exclusive of clerical and subprofessional personnel. The divisions of the Army, WaPrüf 10 and WaPrüf 11 (q v) under General Dornberger, were engaged in research and development of rockets and guided missiles except those with wings, like the V-1 and glide bombs. After Peenemünde was bombed, the wind tunnel and aerodynamic work was moved to Kochel, about 25 miles south of München (See WVA), the theoretical sections were moved to Garmisch-Partenkirchen and the manufacturing and development work was moved to Nordhausen and Bleicherode

203) Peters (J), Berlin NW 21 (Apparatus for chemical and physical testing of explosives)
204) Pfälzische Pulverfabrik A-G, Sankt Ingbert and Schlebusch (Explosives and propellants)
205) Polte Patronenfabrik, Magdeburg, Arnstadt and Grüneberg (Metallic cartridges and ammunition)
206) Pommersche Industrie-Werke GmbH, Barth (Pyrotechnic items, chemical warfare agents, ammunition filling). It employed, during WW II, up to 3600 workers (CIOS 32-13)
207) Pulverfabrik Gebrüder Brudenbach, Junkermühle (Explosives and propellants)
208a) Pulverfabrik Hasloch GmbH. See Dynamit A-G, item i)
208b) Pulverfabrik Rosenheim, Stephanskirchen (Explosives and propellants)
209a) Raubkammer. Proving Ground, located near Lüneburger

Heide, was an Army establishment for testing chemical warfare weapons (Ref 4a, p 85)

209b) Rechlin Testing Station (Rechlin Erprobungsstelle), near Neustrelitz, Mecklenburg, was a proving ground for aircraft (Ref 4a, p 73)

210a) Reichsforschungsrat (State Research Council) was the governing body of the technical institutes (Hochschulinstitute) engaged in research work for the Armed Forces (Ref 4a, pp 71 & 79-80)

210b) Reichsversuchsanstalt für Luftfahrt, Berlin/Adlershof (Government research center for aeronautics)

211) Reinsdorf Plant. See under WASAG

212a) Remo Gewehrfabrik, Suhl, Sachsen (Weapons)

212b) RFR. See Reichsforschungsrat

212c) Rh or Rhm. See Rheinmetall-Borsig A-G

213) Rheinische Dynamit Fabrik, Köln with plants at Opladen and Mansfeld (Industrial explosives)

214) Rheinische Gummi- und Celluloid- Fabrik A-G, Mannheim/Neckarau (Celluloid, celluloid articles and rubber articles) (CIOS 32-38)

215) Rheinische Metallwaren- und Maschinenfabrik A-G, Düsseldorf. See Rheinmetall-Borsig A-G

216) Rheinisches Spritzguss-Werk GmbH, Köln/Braunsfeld (Various items prepared by injection molding) (CIOS 32-38)

217) Rheinisch-Westfälische Sprengstoff A-G, Berlin (Industrial explosives)

218) Rheinmetall-Borsig A-G, Düsseldorf-Derendorf. One of the largest manufacturers of various machines, ammunition (including guided missiles) and weapons. The firm was founded in 1888 as the Rheinische Metallwaren- u Maschinenfabrik A-G, Düsseldorf. In 1929 it merged with the Waffenfabrik Solothurn, Switzerland and in 1936 it merged with the then bankrupt Borsig Werke which possessed a large well-equipped plant at Tegel, a northern suburb of Berlin. The following Rheinmetall-Borsig plants were in operation during WW II:

a) Berlin/Marienfeld
b) Berlin/Tegel
c) Breslau
d) Guben
e) Sömmerda
f) Unterlüss

Note: A proving ground, called Schiessplatz Unterlüss was located near Celle

References:

A) G.M. Chinn. The Machine Gun, U S Govt Printing Office, Washington, D C (1951), p 430
B) BIOS Final Rept 716
C) CIOS Repts 27-79, 31-12 & 32-108

219) Röchling-Buderus A-G, Wetzlar (Centrifugal casting of gun tubes)

220) Röchling Stahlwerke, Volklingen bei Saarbrücken (Steel forging) (CIOS 26-69) (See Röchling Projectile)

221) Rottweil A-G. See item(p) under Dynamit A-G

222) Ruhrchemie A-G, Oberhausen/Holten (Nitric acid) (BIOS 1442, p 22)

223) Ruhrstahl A-G, with several steel works, among them:

a) Annenerwerke, Witten-Annen (Centrifugal casting of gun tubes)
b) Guss-stahlwerke
c) Guss-stahlwerke Witten, Gelsenkirchen
d) Henrickshütte, Hattingen
e) Stahlwerke Krieger, Düsseldorf/Oberkassel

(See BIOS Final Rept 716 and CIOS Repts 27-100, 29-26 and 29-39)

224a) Sächsische Metallwarenfabrik, Aug Wellner, Aue/Sa (Ammunition)

224b) Sauer (J.P.) & Sohn Gewehrfabrik, Suhl was founded in 1751 (Small arms)

225) Schiessplatz Unterlüss (Proving Ground) See also under Rheinmetall-Borsig A-G

Note: According to Simon (Ref 3a, p 130) the Unterlüss station was provided with a full-scale range and all equipment required for conducting exterior ballistics tests.

226) Schuchhardt A-G, Görlitz (Machinery and various weapons)

227) Schutze A-G, Oggersheim, Pfalz (Machinery for manuf of chemicals, propellants and explosives)

228) Sellier & Bellot A-G. See Patronen-, Zündhütchen- und Metallwaren-Fabrik

229) Selve-, Kronbiegel-Dornheim A-G, Sommerda bei Erfurt (Artillery primers and some incendiary bombs) (CIOS 32-38)

230) Siegener Dynamit Fabrik, Köln. Plant at Förde (Industrial explosives)

231) Siegfried Junghans, Schorndorf, bei Stuttgart (Metallurgy) (CIOS 26-71)

232) Siemens-Halske A-G, Berlin was one of the world's greatest electrical organizations with numerous branches and affiliated companies in Germany and foreign countries

Following is a partial list of Siemens plants:
a) Siemens-Reinicke-Werke Berlin, with plants at Erlangen and Rudolfstadt (Electrical equipment such as X-Ray apparatus)
b) Siemens-Schuckert Werke A-G, Berlin (Electrical, cables and some ammunition), with branches in Wien (Austria), London (England), Rio de Janeiro (Brazil), etc
c) Siemens-Wernerwerke, Berlin-Siemensstadt (Dynamos, electric motors, electrical blasting devices, etc)
(See CIOS Rept 28-31)

Note: The present main office and plant are located at Karlsruhe

233) Skoda Werke, Pilsen. See in the Czechoslovakian section

234) Spandau Arsenal, near Berlin. One of the oldest and most important arsenals in Europe

235a) Sperr Versuchsanstalt (lit Barrier-Research Establishment) was a Naval institution engaged in research, development and testing of sea mines (Ref 4a, p 86)

235b) Spreewerke GmbH Metallwarenfabrik, Berlin/Spandau (Weapons)

236) Sprengstoff Fabriken GmbH, Kieselbach (Explosives)

237) Sprengstoff Fabriken Hoppecke A-G, Köln. Plants at Köln, Würgendorf and Hoppecke (Explosives)

238) Sprengstoff- und Zündschnur- Werke, Gnaschwitz A-G Plants at Gnaschwitz and Bautzen (Dynamites, safety explosives and safety fuses) (CIOS 32-38)

239) Sprengstoffwerke Dr Nahsen & Co A-G, Hamburg Plant at Dömitz (Explosives)

240) Staadiches Forschungsinstitut für Metallchemie, Marburg/Lahn (Metallurgical research) [See PB Rept 90651 (1946)]

241a) Stahlwerk Krieger, Düsseldorf/Oberkassel. See Ruhrstahl A-G

241b) Steyr-Daimler-Puch, A-G, Werke, Steyr, Österreich (Weapons)

242) Stotz & Gössl, Suhl (Weapons)

243a) Strempel (F), Suhl (Weapons)

243b) Sundwiger, Messingwerke, vorm Gebrüder Von der Beck, Sundwig, Kr Iserlohn (Ammunition)

243c) SVA. See Sperr Versuchsanstalt

244a) TAL. See Technische Akademie der Luftwaffe.

244b) Tarnewitz Testing Station (Tarnewitz Erprobungsstelle), located on the Ostsee (Baltic Sea) between Lübeck and Rostock was a proving ground for aircraft weapons (Ref 4a, p 73)

244c) Technische Akademie der Luftwaffe, TAL, Berlin/Gatow (Technical Academy of Air Forces) (CIOS 30-71, pp 78-108)

Note: According to Simon (Ref 4a, pp 35-8 & 76-7) the TAL probably did the most advanced scientific research in Germany. Its organization consisted of 13 institutes: mathematics and mechanics, physics, chemistry, materials, mechanisms electricity, communications, flight mechanics, motors aircraft devices, high-pressure work, measurements and ballistics. The Ballistic Institute of the TAL was under the famous ballistician Schardin, former student and collaborator of Carl Cranz. Nearly the entire TAL (except the Ballistics Institute) was evacuated in February 1945 to Bad Blankenburg, near Jena, while the Ballistics Institute was moved to Biberach, near Ulm

245) Temming (P) A-G, Glückstadt (Cotton and wood pulp suitable for manufacture of NC)

246a) Theodor-Ehrlich Maschinen- und Zahnradfabrik, Gotha (Gears of all types) (CIOS 28-46, p 18)

246b) Torpedo Versuchsanstalt (TVA) was a Naval establishment engaged in research, development and testing of torpedoes (Ref 4a, p 86)

246c) Tremonia Experimental Mine. See Versuchsgrube GmbH, Tremonia

246d) TVA. See Torpedo Versuchsanstalt

247a) Udetfeld, bei Gleiwitz, Schlesien, was an Air Force proving ground (named after the German flier Udet) engaged in testing of bombs and bomb fuzes (Ref 4a, p 73)

247b) Unterlüss Proving Ground. See Schiessplatz Unterlüss

248a) VDM. See Vereinigte Deutsche Metallwerke

248b) Venus Waffenwerk, Zella Mehlis (Weapons)

249) Vereinigte Deutsche Metallwerke, (VDM). Sintermetallwerke Neurod, Ettlingen, Karlsruhe (Sintered iron and steel ammunition and weapon components)

250) Vereinigte Leichtmetall Werke GmbH, Hannover, Linden (Aluminum, magnesium and their alloys) (CIOS 31-73)

251) Versuchsgrube GmbH, Tremonia (Experimental mine) (BIOS 1266). See in descriptive part

252) Versuchsstation Heerte, Braunschweig (Rockets, rocket fuels and guided missiles) (CIOS 31-13)

253) Versuchsstrecke Dortmund/Derne (Testing gallery for coal mine explosives) (BIOS 1266) See in descriptive part

254) Voigtländer und Sohn A-G, Braunschweig-Gliesmarode (Physical and optical devices) (CIOS 26-26)

255) Volkswagenwerke, near Fallersleben (Automobiles, jeeps, V-1 missile, Panzerfaust, T-Minen, 250 kg bombs, etc). During WW II about 17000 workers were employed of which 4000 were foreigners (CIOS 28-46)

256a) WaF See Waffen Forschungs

256b) Waffenamt Prüfwesen (WaPrüf) (Army Weapons Office for Developments) was in charge of research, development and testing of army weapons, ammunition and explosives. The WaPrüf consisted of several divisions of which WaPrüf 10 was in charge of liquid-fuel rockets and WaPrüf 11 was responsible for solid-fuel rockets. The so-called WaF (Waffen Forschungs), called also Forschungsabteilung des Heereswaffenamts, was a subordinate division of WaPrüf. It was in charge of research on all weapons with the exception of rockets (Ref 4a, pp 54-60 & 81-4)

257a) Waffenfabrik Mauser A-G. See Mauser Werke A-G

257b) Waffenfabrik Solothurn. See in the Swiss section

257c) Waffen Forschungs (WaF). See under Waffenamt Prüfwesen

258a) Waffenprüfungsstellen des Heeres (Army Proving Grounds) were located at: Kummersdorf, Hillersleben, Gottow, Raubkammer, and Peenemünde (Ref 4a, pp 82-5 and CIOS 27-74 and 30-71)

258b) Waffenprüfungsstelle der Kriegsmarine (Navy Proving-Ground) was located at Meppen

259) Waffenprüfungsstellen der Luftwaffe (Air Force Proving Grounds) were located at Rechlin, Tarnewitz and Udetfeld (Ref 4a, pp 71 & 73)

260a) Walther. See Karl Walther

260b) WaPrüf. See Waffenamt Prüfwesen

261a) WaPrüf 10 and WaPrüf 11. See under Peenemünde and under Waffenamt Prüfwesen

261b) Walter Werke, Kiel (Rockets, rocket fuels, jet propulsion, guided missiles, U-boats, aircraft, etc) (CIOS 30-76 and 30-115)

261c) WASAG. See Westfälisch-Anhaltische Sprengstoff A-G

262) Wasserbau-Versuchsanstalt, (WVA) Kochelsee (Research and development of long range and Flak rockets) (CIOS 30-71)

Note: According to Simon (Ref 4a, pp 33-5 & 130-3), the Wasserbau-Versuchsanstalt was the camouflage name for a section of Peenemünde installations moved to Kochelsee in order to avoid frequent bombings. Extensive work on the exterior ballistics of long-range rockets was done at WVA

263) Werkzeugmaschinenfabrik Oerlikon. See Swiss section

264) Werner-Pfleiderer Maschinenfabriken, Stuttgart-Bad Cannstadt, Württemberg (Mixing and Kneading machines, grainers, etc)

265) Westfälisch-Anhaltische Sprengstoff A-G, Essen (abbreviated to W A S A-G or WASAG) with plants at:

a) Coswig, Anhalt (Various explosives and propellants)
b) Elsnig, Torgau (Hexogen and nitric acid)
c) Herrenwald at Allendorf, Kr Marburg, Lahn (Hexanitrodiphenylamine and ammunition loading)
d) Osnabruck (Nitrocellulose)
e) Reinsdorf, Wittenberg (NGu, propellants, research and development, etc)
f) Sythen, Haltern (NG and industrial explosives)

266a) Westfälische Kupfer- und Messingwerke A-G, vorm O. Noel, Lüdenscheid/Westfalen (Ammunition)

266b) Westfälische Metallindustrie, Lippstadt (Ammunition)

266c) Westlignose A-G, Berlin. Plant at Nussau (Industrial explosives)

267a) Weyersberg (P) & Co Waffenfabrik, Solingen (Weapons)

267b) WIFO. See Wirtschaftliche Forschungs GmbH

268) Wirtschaftliche Forschungs GmbH (WIFO) with plants at:

a) Eferbachtel bei Heiligenstadt (Fuels)
b) Embsen, bei Lüneburg (Nitric acid, research and development center)
c) Langelsheim, Harz (Nitric acid)
(See BIOS 1442, pp 76 & 84 and CIOS 26-68)

269) WKC Waffenfabrik GmbH, Solingen (Weapons)

270) Wolfenfarbenfabrik. See under IG Farbenindustrie

271) Wolff & Co, Walsrode, with plants at:

a) Bömlitz (NC propellants and DEGDN solventless propellants)
b) Dörverden (NC propellants)
c) Fuchburg-Bömlitz (NC propellants)
d) Liebenau (DEGDN propellants)
e) Walsrode (Black powder and NC propellants)

272) Wollmerschässer & Gurth, Berlin-Babelsberg (Stability testing apparatus for explosives and propellants)

273a) Württembergische Metallwarenfabrik A-G, Geislinger Steige, Geislingen (Weapons)

273b) WVA. See Wasserbau-Versuchsanstalt

274a) Zeiss-Ikon A-G, Dresden (Optical, photometrical, piezoelectrical etc devices for ballistic measurements)

274b) Zeiss (Karl), Jena (Optical instruments)

274c) Zelle. A department of the Reichsluftfahrtministerium in charge of construction of aircraft bodies (Ref 4a, p 73)

275a) Zentrale für wissenschaftliches Berichtswesen (ZWB) der Luftfahrtforschung des Generalluftzeugmeisters, Berlin Adlershof (Investigation of aerodynamic properties of glide bombs, etc) [See E.W. Sponder, ZWB Forschungsbericht Nr. 1819 (1943) "Investigation of a Lateral Stability of a Glide Bomb]

Note: According to Simon (Ref 4a, pp 60 & 79), the ZWB stands for "Zentralstelle für wissenschaftliche Berichterstattung" (Central Place for Scientific Reports). Originated by the DVL (Deutsche Versuchsanstalt), the ZWB was handled during the war by the Lilienthal Gesellschaft. All reports on scientific subjects which were of general interest to the air forces were printed and also abstracted on cards by ZWB

275b) Zentralstelle für wissenschaftlich-technische Untersuchungen zu Neubabelsberg bei Berlin (Government research and development center for explosives, ammunition, etc)

276) Zeppelin GmbH, Friedrichshafen and its Subsidiary Maibach Motorenwerke (Diesels, engines, etc) (See also Graf Zeppelin Forschungsinstitut)

277) Zimmermann (E), Leipzig, founded in 1887 (Devices used in ballistic measurements, such as chronographs, etc)

278) Zünderfabrik Müllheim, Ruhr und Saar (Igniters, primers, safety fuses, etc)

279) ~~Zünderwerke Ernst Brünn A-G. See Ernst Brünn GmbH~~

280) Zündhütchen- und Patronenfabrik, vorm Sellier & Bellot. See Patronen-, Zündhütchen- u Metallwaren Fabrik

281) ZWB. See Zentrale für wissenschaftliches Berichtswesen

Note: Many of the war plants in occupied Austria, Belgium Czechoslovakia, France, Holland, Poland and Russia, were forced to work during WW II for Germany. These

plants are listed under corresponding countries.

Following is a partial list of war plants presumably in operation in the Eastern Zone of Germany

A) Celluloidfabrik, Eilenburg (Collodion cotton)
B) Chemisches Werk, Freiberg, Sachsen (Explosives and propellants)
C) Coswig Plant (Sulfuric acid and NG)
D) Magnesit Aken, Kr Dessau, Anhalt
E) Stickstoffwerk Piesteritz (Collodion cotton)
F) VEB Chemisches Werk (Explosives)
G) VEB Sprengstoffwerke, Gnaschwitz (Am nitrate, NG, commercial explosives such as "Arit", Gelatine-Dynamit, safety fuses, etc)
H) VEB Sprengstoffwerke, Schönebeck (Am nitrate, Ammonit, ammunition, Baldurit, blasting caps, Chloratit, Donarit I, Donarit II, fuses, Gelatine-Donarit, NC, NG, NGk, TNT, Wetter-Detonit and Wetter-Halit)
I) VEB Walter Ulbricht, LEUNA (Rocket propellants and jet fuels)
J) VEB WASAG Sprengwerke, Reinsdorf (Explosives and propellants)

Note: Most of these East German plants are already listed in this section under their pre-World War II names.

Abbreviations (Used under War Plants):
A-G (Aktiengesellschaft) Joint Stock Company; Bez (Bezirk) Region; DEGDN Diethyleneglycol dinitrate; I G or IG (Interessengemeinschaft) Trust; Kr (Kreis) District; L A Lead azide; L St Lead styphnate; LEUNA or Leuna Fixed nitrogen plant in E Germany; M F Mercuric fulminate; Nachf (Nachfolger) Successor; NC Nitrocellulose; NG Nitroglycerin; NGc Nitroglycol; NGu Nitroguanidine; NRA National Rifle Association (U S A); Obb (Oberbayern) Upper Bavaria; P A Picric acid; PETN Pentaerythritol tetranitrate; PG Proving Ground; RDX Hexogen u (und) and; VEB (Volkseigener Betrieb) People's Own Works; vorm (vormals) formerly; WW World War.

References:
1) P.Naoúm, Nitroglycerin, etc, Williams & Wilkins, Baltimore (1928), p 14
2) J.Pepin Lehalleur, Poudres, Explosifs et Artifices, Baillière, Paris (1935), p 115
3) O.W.Stickland et al, PB Rept 925 (1945), The General Summary of Explosives Plants
4) O.W.Stickland, PB Rept 1820 (1945), Survey of German Practice and Experience in Filling High-Explosives
4a) L.E.Simon, German Research in World War II, J.Wiley, N Y (1947)
5) G.M.Chinn, The Machine Gun, Bureau of Ordnance, U S Navy, U S Govt Printing Office, Washington, D C, v 1 (Unclassified) (1951)
6) P.B.Sharpe, The Rifle in America, Funk & Wagnalls, N Y (1953), pp 661-3
7) W.H.B.Smith, The NRA Book of Small Arms, The Military Service Publishing Co, Harrisburg, Pennsylvania; v 1 (1953) Pistols and Revolvers, v 2 (1952) Rifles (pp 170 & 527-9)
8) W.H.B.Smith, Small Arms of the World, The Military Service Publishing Co, Harrisburg, Penna (1955)
9a) Dr M.M.Kostevitch, Formerly Colonel in the Russian Imperial Artillery, Buenos Aires, Argentina; private communication
9b) Dr A.Stettbacher, Formerly Professor at the Zürich Polytechnic Institute, Switzerland; private communication
10) Drs H.M.Adam, G.Löhr and R.Weil and Messrs: E.W. Blaszyk, J.F.Hauck, W.F.Schaufelberger, H.A.Tisch and L.G. Van Syckle of Picatinny Arsenal; private communications
11) G.B.Jarrett and K.F.Kempf, Museum, Aberdeen PG; private communications
12) CIOS, Item 22, File 21-3 (1946), Troisdorf Fabrik, D A-G
13) CIOS, Item 2, File 24-3 (1946), Troisdorf Fabrik, D A-G
14) CIOS, Item 2, File 24-4 (1946), Schlebusch Fabrik, D A-G
15) CIOS, Item 2, File 25-16 (1946), Wolfratshausen Fabrik of Dynamit A-G Subsidiary, GmbH zur Verwertung Chemischer Erzeugnisse
16) CIOS, Item 2, File 26-70, (1946), Rottweil A-G
17) CIOS, Item 2, File 27-38 (1946), Stadeln and Wolfratshausen Fabriken, D A-G
18) CIOS, Item 4 & 6, File 28-56 (1946), Elektromechanische Werke, Peenemünde
19) CIOS, Item 2, File 28-61 (1946), Krümmel, Düneberg, and Christianstadt Fabriken, D A-G (Same information as in PB Rept 925)
20) CIOS, Item 2, File 29-24 (1946), German Powder and Explosives Plants
21) CIOS, Item 2, File 29-28 (1946), Kaufbeuren Fabrik, D A-G
22) CIOS, Item 2, File 31-68 (1946) Düneberg Fabrik, A-G
23) CIOS, Item 2, 18, 19 & 21, File 31-70 (1946), Skoda Werke, Pilsen and Böhmische Waffenfabrik, Strakonitz
24) CIOS, Item 2, File 32-8 (1946), Bobingen Fabrik of Dynamit A-G Subsidiary
25) CIOS, Item 2, 3 & 8, File 32-13 (1946), Maschinenfabrik Petersop, Oldenburg, Holstein
26) CIOS, Item 2, File 32-38 (1946), Explosives Summary of Capacities and Production in Germany
27) CIOS, Item 1, 4 & 5, File 32-109 (1946), Luftfahrt Forschungsanstalt at Volkenrode
28) CIOS, Item 2, File 33-20 (1946), Deutsche Waffen and Munitions Fabriken A-G
29) BIOS Reports listed at the beginning of German section

WASAG Underwater Explosives. See under Unterwassersprengstoffe.

Wasserfall (Waterfall). A ground to air guided antiaircraft rocket missile developed during WW II. It was propelled by Visol/Nitric acid (See also Guided Missiles).

References:
1) Anon, Army Ordnance 31, 30 (1946)
2) A.Ducrocq, Les Armes Secrètes Allemandes, Paris (1947), pp 110-121
3) F.Ross, Jr, Guided Missiles, Lothrop, Lee, Sheppard, N Y (1951), p 37
4) K.W.Gatland, Development of the Guided Missiles, Philosophical Library, N Y, (1952), pp 16, 17, 126
5) Gollin, CIOS Report 28-56 (1946), pp 18-24
6) Anon, Dept of the Army Technical Manual, TM 9-1985-2 (1953), pp 219-23.

Wasserstoffperoxyd (Hydrogen Peroxide). See T-Stoff and in the general section under Peroxides

Wasserlöslicher Schiesspulver (Water Soluble Propellant). See Raschig.

Waste or Spent Acids (Abgangssäure oder Abfallsäure) are described in the general section. German methods of recovery of nitric and sulfuric acids, from waste or spent acids resulting from the preparation of explosives and propellant plants, paralleled the practice in the U S A

The procedure used at the Krümmel Fabrik for the recovery of waste acids from explosive oils (such as DEGDN and TEGDN), serving for the preparation of Rohpulvermasse) (q v) deserves to be described here briefly. The denitration was carried out on the spent acid coming from the separator in the nitrating house and from the wash water which resulted from washing the oil in the preliminary washer.

Procedure:

Spent acid (HNO_3 9, H_2SO_4 65, water 21 & DEGDN oil 5%, density 1.66) was sent through a separator to remove the settled explosive oil and then the acid was freed from dissolved explosive oils by running it through the so-called destructor column, heated to about 120° at the bottom and to 160° at the top. In order to assure complete oxidation of explosive oils, the waste acid was usually mixed with some 50% of nitric acid before sending it to the destructor.

Notes:

a) Inasmuch as spent DEGDN acid decomposed rapidly on standing (especially in the presence of moisture), it was not stored for longer than a few hours, but preferably was worked up as soon as the nitration of the DEG was completed

b) It was required that destruction of the explosive oil should be complete and that the resulting acid be light in color. If it was black, the destruction of oil was not complete and the heating had to be continued after adding some more 50% nitric acid

c) For destruction of oils dissolved in wash waters, it was sufficient to run them through the destruction column with live steam

d) The nitrous gases formed in the destructor went to a condenser from which they were drawn into an absorption tower. An acid of about 40-50% strength was recovered. The nitric acid collected in the condenser was bleached by bubbling air through it. This yielded white nitric acid of 38-40% strength

e) The sulfuric acid which flowed from the lower end of the destructor was conducted to a cooler from which it was run to storage tanks. It contained about 71% H_2SO_4 and the density was 1.64. No oxides of nitrogen were permitted to be present and tests were made continuously for them with ferrous sulfate

f) The recovered nitric acid was reheated and passed through an Ausbläser (blow-out column) where the remaining nitrogen oxides were removed by a stream of air. The acid then passed through a syphon into an intermediate container from which it was sent to a storage tank.

Reference: Stickland, PB Rept 925, (1945), p 62.

Weapons. See Table 63 and illustrations on the following pages.

Note: The illustrations of weapons were obtained from the following sources: Museum of Aberdeen Proving Ground (all artillery weapons and most of small arms), Reference 8 (some machine guns) and References 10 and 11 (some pistols and rifles).

The authors wish to express their appreciation to Messrs J.B.Jarrett, K.F.Kempf, H.M.Reed, G.M.Chinn and W.H.B.Smith for use of material listed above.

References (Weapons):
1) J.S.Hatcher, Textbook of Pistols and Revolvers, Small-Arms Technical Publishing Co, Marines, N Carolina (1935)
2) M.M.Johnson, Jr & C.T.Haven, Automatic Arms, W.Morrow, N Y (1942)
3) M.M.Johnson, Jr & C.T.Haven, Ammunition, W.Morrow, N Y (1943)
4) M.M.Johnson, Jr, Rifles and Machine Guns, W.Morrow, N Y (1944)
5) Anon, Recognition Handbook for German Ammunition, Sup Hqs AEF (1945)
5a) Anon, Enemy War Materials Inventory List, SHAEF, Office of AC of SG-4 a (1945)
5b) H.H.M.Pike, CIOS Report 31-68 (1946), Tables 1 to 14
6) L.Simon, German Research in WW II, J.Wiley, N Y (1947)
7) C.R.Jacobs, Official Gun Book, Crown Pub, N Y (1951)
8) G.M.Chinn, The Machine Gun, U S Navy, Bureau of Ordnance, Washington, D C, v 1 (1952); v 3 (1953) (Confidential).
Note: Volume 3 was not used as a source of information for this work.
9) Anon, German Explosive Ordnance, Dept of the Army Tech Manual TM 9-1985-2 and 9-1985-3, Washington, D C (1953)
10) W.H.B. Smith, The NRA Book of Small Arms, Military Service Publishing Co, Harrisburg, Penna, v 1 Pistols and Revolvers (1953) and vol 2 Rifles (1952)
11) W.H.B. Smith, Small Arms of the World Military Service Publishing Co, Harrisburg Penna (1955) (Gives also an historical description of the development of German small arms)
12) Col J.B.Jarrett, and Messrs K.F.Kempf and H.M.Reed of Museum Aberdeen Proving Ground, Maryland; private communication
13) J.E.Capell, A.B.Schilling G.Coghlan and H.H.Bullock of Picatinny Arsenal, Dover, New Jersey; private communication (1955)
Note: An historical description of the development of German artillery weapons may be found in the book by Capt James E Hicks, "Notes on German Ordnance 1841-1918," 428 Rick Ave, Mt Vernon, N Y
14) P.B.Sharpe, Rifle in America, Funk & Wagnalls, N Y (1953)
15) Anon, Intelligence Bulletins Washington D C, (1955).
Note: These bulletins were not used as sources of information for this work.

Weapons, Internal Ballistic Data. H.H.M.Pike gives, at the end of CIOS Report 31-68 (1945), several tables listing German weapons from 20 mm to 800 mm, the types of propellants used by them, size of grains, weight of charge, type and weight of projectiles, length and capacity of chamber, shot travel, total capacity, pressure and muzzle velocity.

"Weissmann" Zünder. Pressure type igniter designed for use in improvised mines (as a push igniter) or in some HE charges (as an impact igniter). See also under Igniter.

Weisspulver. See Raschig's White Powder.

Weiss-Salz (White Salt). A compound, $(H_2C:N.SO_3K)_x$, produced in 1944 by the IG Farbenindustrie at Höchst am Main, as an intermediate in the manufacture of Hexogen. The compound was shipped to the Nobel plant at Hamburg, where it was nitrated. The production of white salt was stopped as soon as the method of direct nitration of hexamethylenetetramine to Hexogen was improved to make it more economical. Weiss-Salz was prepared as follows:

a) Ammonia and sulfur trioxide reacted to give the ammonium salt of aminosulfonic acid, $H_2N.SO_2.ONH_4$

b) On treating it with KOH, the corresponding potassium salt was obtained

c) On treating the K salt with formaldehyde the Weiss-salz was obtained.

Reference: R.E.Richardson et al, CIOS Rept 25-18 (1945), pp 28-29.

Westfalit (Westphalite). A series of explosives proposed by Bielefeldt in 1895. The original composition contained Am nitrate 95 and resin 5%. It was later modified to the one containing Am nitrate 91, K nitrate 4 and resin 5%. Its velocity of detonation was 4350 m/sec at density 1.01. The last composition was also called the Westfalit für Kohle (Coal Westphalite) (Ref 3).

Note: Although Westphalites were fairly safe for use in gaseous coal mines, the Westfälisch-Anhaltische Sprengstoff A-G proposed to add to them 3 to 5% of chromium salts to act as cooling agents. Some Westphalites were manufactured in England.

References:
1) Daniel, Dictionnaire (1902), pp 804-6
2) Marshall Explosives v 1 (1917), p 389
3) Barnett, Explosives (1919), p 113.

Westphalite. See Westfalit.

WETTERSPRENGSTOFFE (Explosives Safe for Use in the Presence of Firedamp). A series of coal mining explosives approximately corresponding to American Permissible Explosives or French "Explosifs antigrisouteux." Table 64 lists these explosives (See pp 260-61).

WEAPONS (Waffen) may be subdivided into:
A. **Small Arms** (Handfeuerwaffen), which include: pistol (Pistole) revolver (Revolver), carbine (Karbiner), rifle (Gewehr), machine gun (Maschinengewehr) and submachine gun (Maschinenpistole) models
B. **Artillery Pieces** (Geschütze), which include: cannon (Kanone), howitzer (Haubitze) and mortar (Mörser) models

C. **Rocket Launchers** (Raketenwurfmaschinen), which include: Faustpatrone, Panzerfaust, Panzerschreck (Raketenpanzerbüchse 54), Püppchen (Raketenwerfer 43) and others.

Most of the German weapons used in WW I and II may be found on display in the Museum of Aberdeen Proving Ground, Maryland.

Table 63, following, gives some of the characteristics of German small arms, artillery pieces and rocket launchers.

Table 63 (Weapons)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
6.35 mm (.250") Mauser Automatic Pistol M 1910, called Westtaschenpistole (WTP), Vest Pocket Pistol	Length: barrel 2.03" and overall 4.06"; wt 10.22 oz and a capacity of 6 rounds. One of the best small pistols ever produced	2, p 321; 4, pp 275-8 & 10, v1, pp 141 & 560
6.35 mm Walther Pistols Models 1 (1908) and 2 (1919)	Blowback vest pocket pistols using .25 CAC	11, p 478
6.35 mm Walther Pistols Models 5 (1913), 8 (1920) and 9 (1921)	Streamlined versions of above pistols	11, p 478 & Ref 12
6.35 mm Pistols: Bergmann, Origies, Sauer and others	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
6.5 mm (.256") Bergmann Automatic Pistol	One of the earliest small size pistols	7, p 27
6.5 mm Mauser Vest Pocket Automatic Pistols, Types WTP I (1910) and WTP II (1919)	Elementary blowback pistols resembling the Browning types. The Type II was the streamlined version of Type I	11, p 485
6.5 mm Sauer & Sohn Vest Pocket Pistols, Types I and IA	Resembled a Browning in external appearance. Capacity 7	11, p 484
7.63 mm (.300") Military Mauser Automatic Pistol, called Maschinen Pistole, developed in 1895 and used during WW I	Recoil-operated pistol weighing 45 oz. Capacity 10. Could be fired with shoulder stock holster attached	2, p 321; 4, pp 275-8; 7, p 27; 10, v1, pp 167-176, & 11 pp 464-8
Note: According to Ref 8, v1, p 177 there was also an improved model (M1926) of the above pistol		
7.63 mm Mauser Machine Pistol M 1932, called Schnell-Feuer Pistole (Rapid-Fire Pistol issued to SS troops. Was also manufd in Spain under the name of ASTRA	Recoil-operated weapon which may be considered as intermediate between the pistol and the submachine gun. Length of barrel 5¼", overall 12", wt 45 oz, capacity 10 or 12 cartridges, mz vel up to 1600 ft/sec	8, v1, p 177 & 11, pp 468-71
7.65 mm (.301") Automatic Pistol, introduced in Germany in 1893 by an American Hugo Borchardt	Considered as the forerunner of the Luger. Could use 7.63 mm Mauser ammunition	7, p 27 & 10, v1, p 185
7.65 mm Mannlicher Pistol invented in 1900	Was also made in caliber 7.63 mm	7, p 27
7.65 mm Luger (Parabellum) Pistols M 1900 and M 1900/06 were used during WW I. Model 1900 was an official Swiss pistol	Barrel length 4¾". Used cartridges contg 10 gr of smokeless prop and a bullet weighing 93 gr. Mz vel 1250 ft/sec	2, p 320; 3, p 187; 7, p 27 & 10, v1, p 182
Note: According to Smith (Ref 9, p 462) the original Luger was designed by an American, Borchardt, and was further developed by a German, Leuger. It was first manufd under the name of "Borchardt-Leuger" and later corrupted and shortened in the U S A to the name "Luger." The name "Parabellum", which literally means in Latin "for war", is used in Europe. See also 9 mm Luger (Parabellum) Pistols		
7.65 mm Luger Automatic Carbine (Parabellum Karabiner)	It consisted of a regular Luger pistol provided with a detachable wood stock and a long barrel with a checkered wooden fore-end	10, v1, p 184
7.65 mm Dreyse Automatic Pistol M 1907	Blowback-action pistol weighing 24 oz; capacity 8	10, v1, pp 233-5 & 582 & Ref 12
7.65 mm Beholla Automatic Pistol manufd by Becker & Holländer, Suhl	Blowback-action pistol wighing ca 22 oz. Was used during both WWs. Capacity 7	10, v1, pp 218 & 579
7.65 mm DWM Automatic Pistol, manufd by the Deutsche Waffen- u Munitionsfabriken	Blowback-action pistol weighing 20½ oz. Capacity 7	10, v1, pp 235-6
7.65 mm Automatic Pistol invented by F.Langenham of Suhl and called F L Selbstlader (F L Self-loader)	Blowback-action pistol weighing 22.9 oz, capacity 8. Was used during WW I as a substitute officer's pistol	10, v1, pp 243-5 & 585
7.65 mm Automatic Pistol, called PB Special Model III, manufd by A.Menz, Suhl	Double-action blowback pistol which closely resembled Walther PPK	10, v1, pp 253-4 & 588
7.65 mm Ortgies Automatic Pistol (manufd by the Deutsche Werke, Erfurt)	Striker-fired blowback pistol	10, v1, pp 254-6
7.65 mm Jäger Automatic Pistol	A blowback-operated pistol of simple and most unusual design	10, v1, pp 248-3 & 585 & Ref 12
7.65 mm Mauser Automatic Pocket Pistol M 1910	A straight blowback-action pistol weighing 21.5 oz. Capacity 9	10, v1, pp 246-9 & 587

WEAPONS
(PISTOLS AND REVOLVERS)

PICATINNY ARSENAL
TECHNICAL REPORT NO. 2510

DICTIONARY OF EXPLOSIVES, AMMUNITION AND WEAPONS

(GERMAN SECTION)

BASIL T. FEDOROFF

HENRY A. AARONSON GEORGE D. CLIFT EARL F. REESE

DOVER, NEW JERSEY
1958

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
7.65 mm Mauser Automatic Pistol, HSc (Hammer-Self-loading)	Double-action blowback pistol, length barrel 3 3/8" and overall 6½". Wt 20.6 oz and capacity 8 cartridges, either 7.65 mm Browning or .32 CAP	10, v 1, pp 246-9 & 587 & 11, pp 472-3
7.65 mm Rheinmetall Automatic Pistol	Blowback-operated pistol weighing 23.6 oz	10, v 1, pp 254-6
7.65 mm Roth-Sauer Automatic Pistol was somewhat similar to the Austro-Hungarian Roth-Steyr pistols	Long recoil-operated weapon weighing 23 oz with capacity 7 cartridges, caliber .301	10, v 1, pp 208-9 & 11, p 483
7.65 mm Sauer Automatic Pistol M 1908 manufd by J.P. Sauer & Sohn, Suhl	Was replaced after WW I by M 1930 and and M 1938	10, v 1, pp 258, 260-1 & 590
7.65 mm Sauer Automatic Pistole M 1913 and Behördenmodell (Authority Model)	Blowback-operated weapon, capacity 7. The Behördenmodell was widely used by military and police officials	11, p 485
7.65 mm Sauer Automatic Pistol M 1930	Streamlined modification of earlier models	10, v 1, p 259
7.65 mm Sauer Double Action Automatic Pistol M 1930 (called also Model H) was widely used during WW II by the German air and tank forces. Considered one of the world's best pocket pistols	Straight blowback-action weapon. Length of barrel 3⅝" and overall 6½", Wt 22 oz, capacity 8 cartridges either 7.65 mm Browning or .32 CAP	10, v 1, pp 259-& 262-4 and 11, pp 474-7
7.65 mm Walther Pistole Models 3 (1909), 5 (1910), 6 and 7 (1917), manufd by K. Walther of Zella Mehlis	Blowback-action weapons using .32 CAP cartridges	10, v 1, pp 286-7 & 594 & 11, p 478
7.65 mm Walther Pistol PP (Polizei Pistole), introduced in 1921	Holster type pistol widely used by police forces throughout Europe.	10, v 1, pp 286-7 & 11, p 478
7.65 mm Walther Pistol PPK (Polizei Pistole Kriminal), introduced in 1929 and manufd in great numbers.	Designed for detectives who carry their weapons concealed	10, v 1, pp 286-92; 11, p 478 & Ref 12
7.9 mm (.311") Rifle M 1888 (Gewehr 88, abbreviated to Gew 88) and developed by a German Military Commission. It combined a modified Mauser (M1871) two-piece bolt system with a modified Mannlicher loading system (magazine)	Prototype of Army rifles used in both WWs. The first 500,000 rifles were made in 1888 by L. Loewe & Co, Berlin. The carbine (Karabiner) was slightly shorter and lighter than the rifle. Both of them used rimmed, necked, center-fire cartridges with round nose bullets	10, v 2, pp 201-15; 11, pp 425-7 and Ref 10
7.92 mm (.312") Mauser Rifle M1898 (Gewehr 98); Bolt Action, was the standard German Infantry Rifle of WW I and the early form of all modern Mauser rifles. Served as prototype for military rifles of many European and South American countries	Length of barrel 29.15" and overall (without bayonet) 49.25", wt 9.5 lb. Capacity 5 rimless, necked, center-fire cartridges with pointed bullet (Spitzer). Max vel 875 m/sec (2807 ft/sec) and pressure 3500 atm (51333 psi)	4, pp 83-90; 10, v 2, pp 171 & 215; 11, pp 427-8 and Ref 12

Note: Originally Gew 98 used a round nosed bullet (same as in M 1888) which had a slightly smaller diam than the pointed bullet. In order to take the new bullet it was necessary to enlarge the diam of Gew 98

Caliber and Designation	Remarks, Uses and Some Characteristics	References
7.92 mm Mauser Carbine 1898 (Karabiner 98, abbr to Kar 98). Original model	Cavalry version of Gew 98. Barrel length 18"	11, p 428
7.92 mm Mauser Carbine 1898 which was introduced in 1904 and adopted in 1908 for use by artillery and engineer (pioneer) personnel	Cut-down version of Gew 98. Length of barrel 24" and overall 43.5"; wt 8.2 lb; capacity 5	4, pp 85-90; 10, v 2, pp 171-5; and 11, p 428
7.92 mm Kar-98a was introduced after WW I by the Reichswehr	Slightly modified version of Kar 98. Was used in WW II	10, v 2, pp 171 & 177 & 11, p 429
7.92 mm Kar-98b, developed after WW I by the Reichswehr for cavalry and armored forces use	It differed from Kar 98 in having a bent-down bolt handle and side sling. Was used during WW II	10, v 2, pp 171 & 177 and 11, p 429
7.92 mm Karabiner 98 h (Kb-98h)	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Semi-Automatic Rifle, Model 1915	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Gewehr 98/17, developed during WW I and discarded after it	Slightly modified version of Gew 98 designed to permit speeding up manuf by reducing machine operations	10, v 2, pp 175-6
7.92 mm Gewehr 18, developed after WW I as an experimental model	Was provided with magazines of 5, 10 and 25 round capacities	10, v 2, pp 176-7
7.92 mm Machine Gun M 1908 (MG-08)	Short recoil-operated, water-cooled MG used during WW I. Wt 40.5 lb with feed	8, v 1, pp 309 & 662
7.92 mm Machine Gun M 1908/15 (MG-08/15) Maxim	A lighter version of MG 08, which weighed 30 and 31 lb. Its air-cooled version, manufd at Spandau Arsenal, was called Spandau Machine Gun	8, v 1, pp 309 & 314; 11, pp 517-20 and Ref 12

WEAPONS

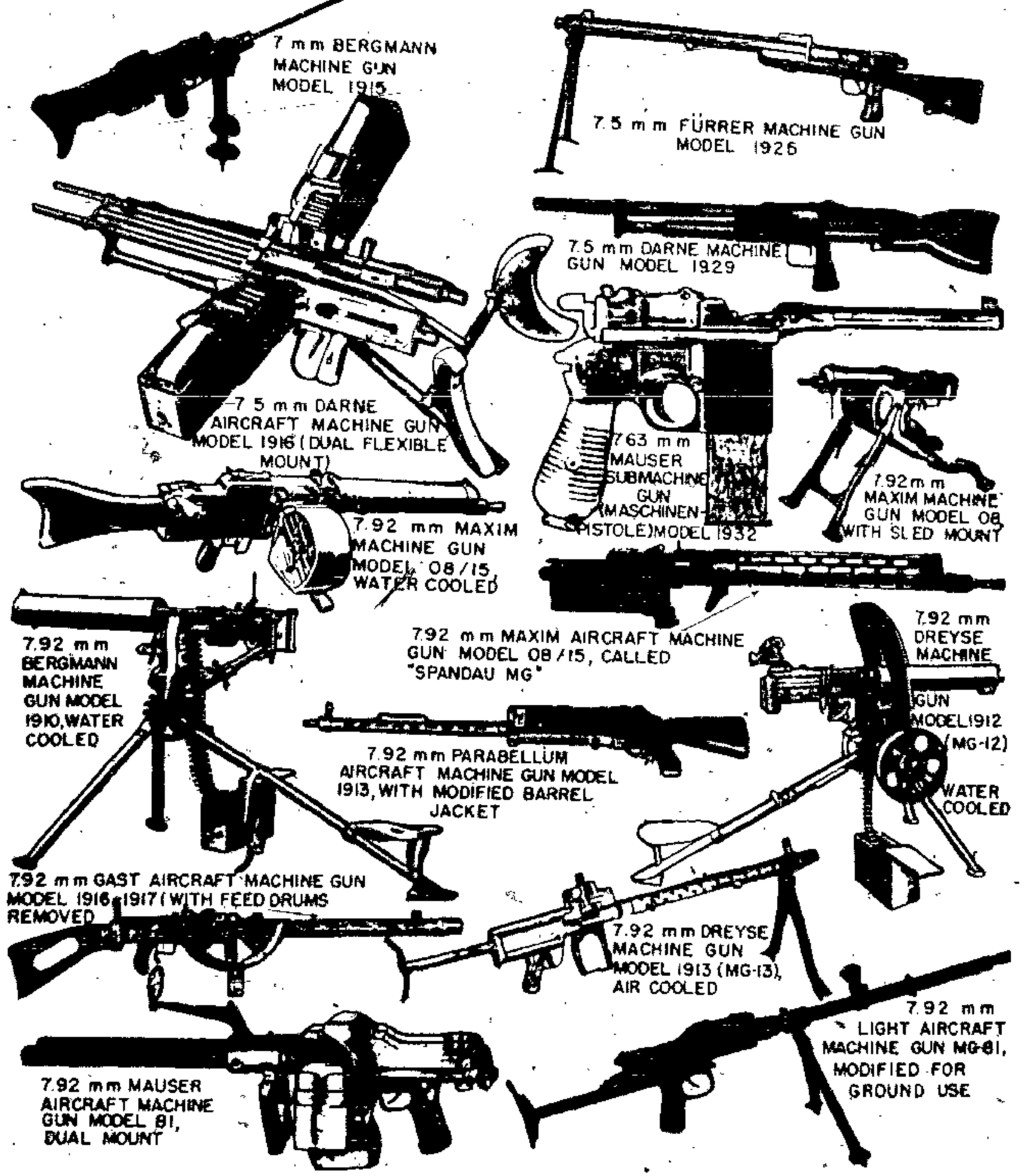
(CARBINES AND RIFLES)

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
7.92 mm Bergmann Machine Gun M 1910 was invented prior to 1900 and improved in 1903 and 1910	Short recoil-operated, water-cooled MG weighing (with feed) 36 lb	8, v 1, pp 214-16 & 658
7.92 mm Dreyse Machine Gun M 1912 was invented in 1907 [illegible] L.S [illegible] Dreyse, the inventor of the "needle gun"	[illegible] 37.5 lb. Was used during WW I	8, v 1, pp [illegible] 660 & Ref 12
7.92 mm Dreyse Machine Gun, called MG-13	Air-cooled MG, secretely manufd after WW I in violation of Versailles treaty	8, v 1, pp 367-70 and Ref 12
7.92 mm Parabellum Light Machine Gun M 1913, manufd by DWM and used during WW I	Short recoil-operated, air-cooled MG weighing (with feed) 22 lb	2, p 314; 8, v 1, pp 310-13 & 662 and Ref 12
7.92 mm Bergmann Aircraft, Machine Guns M 1915 and M 1915 NA (New Pattern) were used during WW I	Short recoil-operated, air-cooled MGs weighing 36 lb (with feed)	2, p 315; 8, v 1, pp 365-7 & 658 and Ref 12
7.92 mm Gast Double-Barrel Aircraft Machine Gun M 1918	Recoil and gas-actuated, air-cooled MG weighing 60 lb. It was secretely manufd after WW I	8, v 1, p 379
7.92 mm Solothurn Machine Gun M 1929	Short recoil-operated, air-cooled MG weighing only 17 lb	8, v 1, pp 453 & 664
7.92 mm Solothurn Machine Gun M 1930	Short recoil-operated, air-cooled MG weighing 18.5 lb	8, v 1, pp 453-4 & 664
[illegible] Aircraft Machine Gun, [illegible] 932 under the name of [illegible] 15 (MG-15)	Short recoil-operated, air-cooled MG weighing 27½ lb	8, v 1, pp 445 & 662
7.92 mm Aircraft [illegible] adopted before WW II under [illegible] of Maschinengewehr 17 (MG-17)	An improved version of MG-15. Wt (with feed) 27½ lb	8, v 1, pp 455-6 & 662
7.92 mm Mauser Carbine M 1898, Short (Karabiner 98 Kurz, abbr to Kar-98K or Kb-98K), mass produced beginning 1935. Was the principal military small arm used during WW II. Its essential difference from Gew 98 was in the improved bolt sleeve, sights and shorter barrel	Length or [illegible] overall (without bayonet) 43.5"; [illegible] Type of action: turnbolt-rotating [illegible] type of bolt: one piece rotating head; type of magazine: box-staggered column; capacity: 5 rimless, necked, center-fire cartridges as in Kar 98. Muz vel 2800 ft/sec	10, v 2, pp 170, 174 & 179; 11, pp 422, 429-30 and Ref 12
7.92 mm Grenade Rifle (Launcher Grenade) (Modification of Karabiner 98 K)	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Knorr-Bremse Machine Guns M 1933 and M 1935/36 were developed by H.Lauf of the Knorr-Bremse Manufg Co, Lichtenberg	Gas-operated air-cooled MGs. The latest model weighed 18½ lb (with feed)	8, v 1, pp 469-71 & 660
7.92 mm Mauser Light Machine Gun, called MG-34, was developed about 1934 at the Mauser Plant and became the standard MG of the German Army	Short recoil-operated, air-cooled MG weighing 24½ lb (with feed). Barrel length 23½", mux vel ca 2750 ft/sec; rate of fire 750-800 rpm and range 5000 yd	8, v 1, pp 472-4 & 662; 11, pp 503-8 and Ref 12
7.92 mm Light Machine Guns MG-34 (Modified MG-34s and MG-34/41)	Slightly modified versions of MG-34	8, v 1, pp 475-7 and Ref 12
7.92 mm Light Machine Gun MG-81, developed in 1938 at the Mauser plant (Aircraft Model)	Recoil-operated and air-cooled. Wt (with feed) 13¾ lb, rate of fire 1200-1300 rpm and muz vel 2750 ft/sec. It was a modification of the MG-34, designed for flexible mounting	8, v 1, pp 478-9 & 662
7.92 mm Light Machine Gun MG-81, ground use	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Aircraft Machine Gun, Model 39 (Krieghoff)	Same as above	12
7.92 mm Antitank Rifles PzB-38, PzB-39 and PzB-40 (Krieghoff)	Same as above	12
7.92 mm Gewehr 98/40 (Modification of the Hungarian Service Rifle M 1935)	Essentially the Mannlicher-Schönauer turnbolt rifle equiped with a Mauser type magazine. Overall length 43.5", barrel 24", wt 9 lb	11, p 430 and Ref 12

WEAPONS

(SUBMACHINE GUNS AND MACHINE GUNS)



(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
7.92 mm Gewehr 33/40 (Modification of Czech Model 33)	Short weapon (barrel 18") used by mountain and ski troops	11, p 430 and Ref 12
7.92 mm Gewehr 98/40 and 29/40 Mauser	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Antitank Rifle, Model SS-41	Same as above	12
7.92 mm Semi-Automatic Rifle Model 41-M (Halbautomatisches Gewehr 41-M) developed at Mauser plant	Gas-operated weapon which did not prove to be successful in field use	10, v 2, pp 187-8 & 11, pp 432 & 438 and Ref 12
7.92 mm Semi-Automatic Rifles Gew-41 (G-41) and its improved version G-41W were designed by Walther	Experimental gas-operating weapons incorporating some features found in pre-WW II Russian Degtiarev, Simonov and Tokarev weapons	4, pp 111-13; 10, v 2, pp 188-9; 11, pp 432-7 & Ref 12
7.92 mm Semi-Automatic Rifle M 1943 (Gew-43) and Carbine M 1943) (Kar-43) were developed during WW II in order to do away with some defects of G-41 and G-41W weapons	These weapons were gas operated and the action was of the straight-line (non-rotating) bolt type. Characteristics of Gew 43: overall length 44.5", barrel 22", wt 8.9 and magazine capacity 10 cartridges from two Mauser 5-round clips	10, v 2, pp 189-197 & 11, pp 439-43
7.92 mm Automatic Rifle, M 1942 (Light Machine Gun), called Fallschirmjäger Gewehr 42 (Paratrooper's Rifle 42), abbr to FG-42. It was fitted with a folding bipod mount	Gas-operated, air-cooled weapon of revolutionary design. Overall length (without bayonet) ca 42", barrel ca 19" and wt 9¾ lb (without magazine). Magazine: straight box inserted on the left side	4, pp 176-79; 8, v 1, p 489-91; 11, p 444 and Ref 12

Note: This weapon was manufd by the H.Krieghoff Waffenfabrik, Suhl. It was also made in the U S A under the designation of T-44

Caliber and Designation	Remarks, Uses and Some Characteristics	References
7.92 mm Automatic Rifle, M 1942, Modified	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Light Machine Gun, MG-42 was the latest German machine weapon of WW II and the most remarkable gun of its type ever produced in any country of the world. MG-42 incorporated the best features of previous Russian and German MGs	Short recoil-operated, air-cooled MG weighing 24 lb (with feed). Rate of fire 1200-1350 rpm and muz vel 2570 ft/sec. Used 7.92 mm German Service ammunition	4, pp 176-9; 8, v 1, pp 484-8 & 662; 11, pp 509-16 & Ref 12
7.92 mm Machine Carbine (Maschinenkarabiner, abbr to MKb-42)	Was used on the Russian front. Its improved version appeared in 1943 on the Western front under the designation MP-43. It was practically identical with MP-44 described below	11, pp 500 and 502
7.92 mm Machine Carbines MKb-42 (H) and MKb-42(W), Called also Submachine Guns	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
7.92 mm Carbine 1943, Kb-43	Same as above	12
7.92 mm Machine Pistol M 1944 (Maschinenpistole 44), was originally developed in 1942 and then improved in 1943. On Hitler's order it was called Sturmgewehr 44 (StuG-44)	Gas-operated, air-cooled weapon of remarkable design and manuf. It was practically identical with Maschinenpistole 43 (MP-43) and Karabiner 44 (K-44). Overall length 36⅞", barrel ca 16", wt (not given), capacity 30 cartridges of special design	11, pp 499-501 and Ref 12

Note: The cartridge used in the latest 7.92 mm weapons, such as machine carbines and machine pistols, was a cut-down version of the standard bottle-neck rifle cartridge using a 125 grain pointed bullet. Muzzle velocity was ca 2250 ft/sec and good accuracy was obtained at an effective range of at least 400 yd. (The Germans claimed an effective range of ca 650 yd) (Ref 11, p 502)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
7.92 mm People's Rifle 1 (Volkssturm Gewehr I, abbr to VG-1), manufd by K.Walther, Suhl	Short, turnbolt action rifle, manufd with the intention of issuing it to civilians for home defense. Overall length 43", barrel 23.2", wt 8.3 lb and magazine capacity 10	10, v 2, pp 181-3; 11, p 431 and Ref 12
7.92 mm People's Rifle Special (Short) was developed in 1942 by Haenel of Suhl and introduced in 1945	Weapon of very original design and of great simplicity. Overall length 34.9", barrel 14.9", wt 9.4 lb and magazine capacity 30	10, v 2, pp 198-9 & 11, pp 445-7
8 mm (.315") Schwarzlose Machine Gun M 1907/12, invented by A.W.Schwarzlose of Germany and first manufd by the Steyr Arms Works in Austria	Operated by retarded blow-back and cooled by water. Wt 46½ lb, muz vel 1875 ft/sec and rate of fire 400-450 rpm	8, v 1, pp 228-31

WEAPONS

(SUBMACHINE GUNS AND MACHINE GUNS)

UPPER PHOTO - 7.92 mm MAUSER MACHINE GUN MODEL 1934 (MG-34) MOUNTED ON A TRIPOD FOR USE AS A HEAVY MACHINE GUN

LOWER PHOTO - 7.92 mm MAUSER MACHINE GUN (MG-34) (USED AS A LIGHT MACHINE GUN WITH A 50-SHOT DRUM MAGAZINE)

7.92 mm MAUSER MACHINE GUN MODEL 1934 S

7.92 mm KNORR-BREMSE MACHINE GUN MODEL 35/36

7.92 mm KRIEGHOFF AIRCRAFT MACHINE GUN MODEL 1939 (MG-39)

7.92 mm SUBMACHINE GUN [MASCHINENKARABINER 42 (H)]

7.92 mm LIGHT MACHINE GUN MODEL 1942 (MG-42)

7.92 mm WALTHER SUBMACHINE GUN MACHINENKARABINER 42 (W)

7.92 mm SUBMACHINE GUN (MACHINENPISTOLE MP-43)

7.92 mm SUBMACHINE GUN (MP-43/1)

7.92 mm MACHINE GUN MODEL 42, MOUNTED ON A TRIPOD

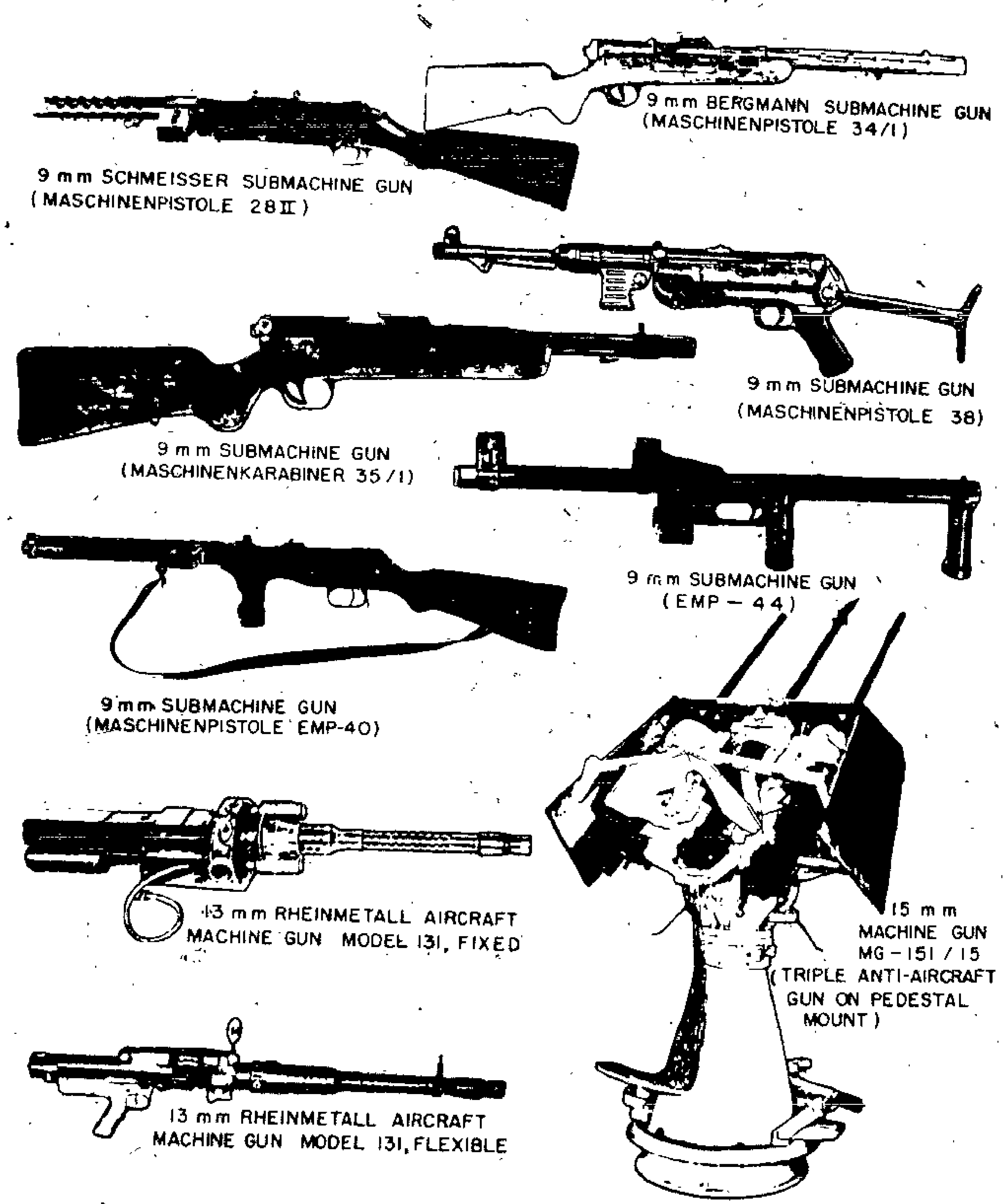
7.92 mm SUBMACHINE GUN [MP-44 OR STUG (STURMGEWEHR) 44]

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
9 mm (.354") Luger (Parabellum) Automatic Pistols Models 1902, 1902/06, 1904 and 1904/06 (M 02, M 02/06, M 04 and M 04/06)	Barrel lengths: 4" for M 02 & M 02/06 and 6" for M 04 and M 04/06. The last two models were issued with a leather holster attached to a wooden stock. The M 04 was an official German Navy weapon used during WW I	4, pp 271-3; 10, v 1, pp 182 & 417-18 and Ref 12
[See also Note given under 7.65 mm Luger (Parabellum) Pistols M 1900 and 1900 and 1900/06]		
9 mm Luger (Parabellum) Automatic Pistol Model 1908 (Official German Army Weapon of both WWs). It was slightly modified in 1920	Recoil-operated. Lengths: barrel 4" and overall 8¾"; wt 30 oz, magazine capacity 8 cartridges with round or flat point bullets weighing 110 and 125 grains. Max vel 1040 to 1300 ft/sec	10, v 1, pp 182 & 418-19; 11, pp 456-63 and Ref 12
Note: Special 6", 8" and 10" barrels were provided for this pistol. The model using an 8" barrel and called 9 mm Parabellum M 08 Lang (long) was issued to artillery and "Z" boat personnel		
9 mm Mauser Automatic Pistol, Military Model, also called Maschinenpistole. Used in WW I and to a limited extent in WW II	Same design as 7.63 mm Mauser. Magazine capacity 10 Luger cartridges. Could be fired with shoulder stock holster attached to magazine	4, pp 275-8; 10, v 1, p 420 and Ref 12
9 mm Bergmann Automatic Pistol M 1910 was manufd for the Greek Army. There was also a Model 18-1	Similar in size and design to the Belgian 9 mm Bergmann-Bayard except that it was lighter (32 oz)	10, v 1, pp 439-41; 11, p 491 and Ref 12
9 mm Bergmann Automatic Pistol (Maschinenpistole) M 1934, called also Submachine Gun	Modification of Model 18-1	11, pp 491-2 and Ref 12
Note: This weapon was officially adopted by Sweden in 1937 and for this reason is briefly described in the Swedish section.		
9 mm Steyr Automatic Pistol, invented prior to WW I	Recoil-operated; magazine capacity 8 rounds	2, p 322
9 mm Steyr-Solothurn Automatic Pistol (Maschinenpistole) (MP), called in the U S A Submachine Gun and in Gt Britain Machine Carbine. Also designated as SI-100	Operated by recoil on the blowback principle. Overall length 32½"; wt 9¾ lbs; magazine capacity 30 Parabellum cartridges. Max vel 1100 to 1600 ft/sec	4, pp 246-8; 11, pp 496-7 and Ref 12
9 mm Walther Automatic Pistol, invented before WW I	Blowback-operated. Served as the prototype for later models. Capacity 8	2, p 322
9 mm Walther Automatic Pistol, originally introduced as Model HR was officially designated as P-38. This model was called "Walther Armee Pistole"	Operated by short recoil. Length barrel 4⅞" and overall 8½"; wt 34 oz; magazine capacity 8 Parabellum cartridges	2, p 322; 4, pp 278-80; 10, v 1, pp 425-32; 11, pp 450-55 and Ref 12
Note: Several factories manufd it during WW II and it was extensively used by the Armed Forces		
9 mm Schmeisser Machine Pistol, MP-28 II	Blowback-operated. Length barrel 7.8" and overall 31.6"; wt 9 lb; capacity 32 Parabellum cartridges	11, p 495 and Ref 12
9 mm Schmeisser Maschinen Pistole 38 (MP-38), called in the U S A Submachine Gun, Parachute Model	Operated by blowback. Overall length (with stock extended) 35"; wt (without magazine) 9 lb. Magazine capacity 32 Parabellum cartridges	11, pp 486-9 and Ref 12
9 mm Submachine Gun, MP-34/1, Bergmann	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
9 mm Machine Carbine, M-35/1	Same as above	12
9 mm Schmeisser Maschinen Pistole (MP-40) called in the U S A Submachine Gun and Burp Gun	Slight modification of MP-38; same dimensions. Cyclic rate of fire 500 rpm	4, pp 248-50; 7 p 37; 11 p 490 and Ref 1
9 mm Automatic Browning Pistol, M 1935, designed 10 years earlier by J.M.Browning. Was used during WW II by SS troops	Recoil-operated; length: barrel 4⅝" and overall 7¾"; wt 35 oz; capacity 13	10, v 1, pp 404-8
9 mm Dreyse Automatic Pistol, Military Model	One of the earliest blowback operated pistols, manufd in the closing years of WW I	10, v 1, pp 408-10
9 mm Erma Machine Pistol, sometimes called the Schmeisser Machine Pistol or Carbine	Overall length 33½", wt 9 lb and cyclic rate of fire 520 rpm	11, p 493
9 mm Neuhausen Machine Pistol	Capacity 40 cartridges; wt of pistol 9 lb 2 oz	11, p 494
9 mm Submachine Guns EMP-40 and EMP-44	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
10.15 mm (.40") Norwegian Rifle	Used Norwegian ball ammo, type 522	5a, p 8

WEAPONS

(SUBMACHINE GUNS AND MACHINE GUNS)



(Weapons) (cont'd)

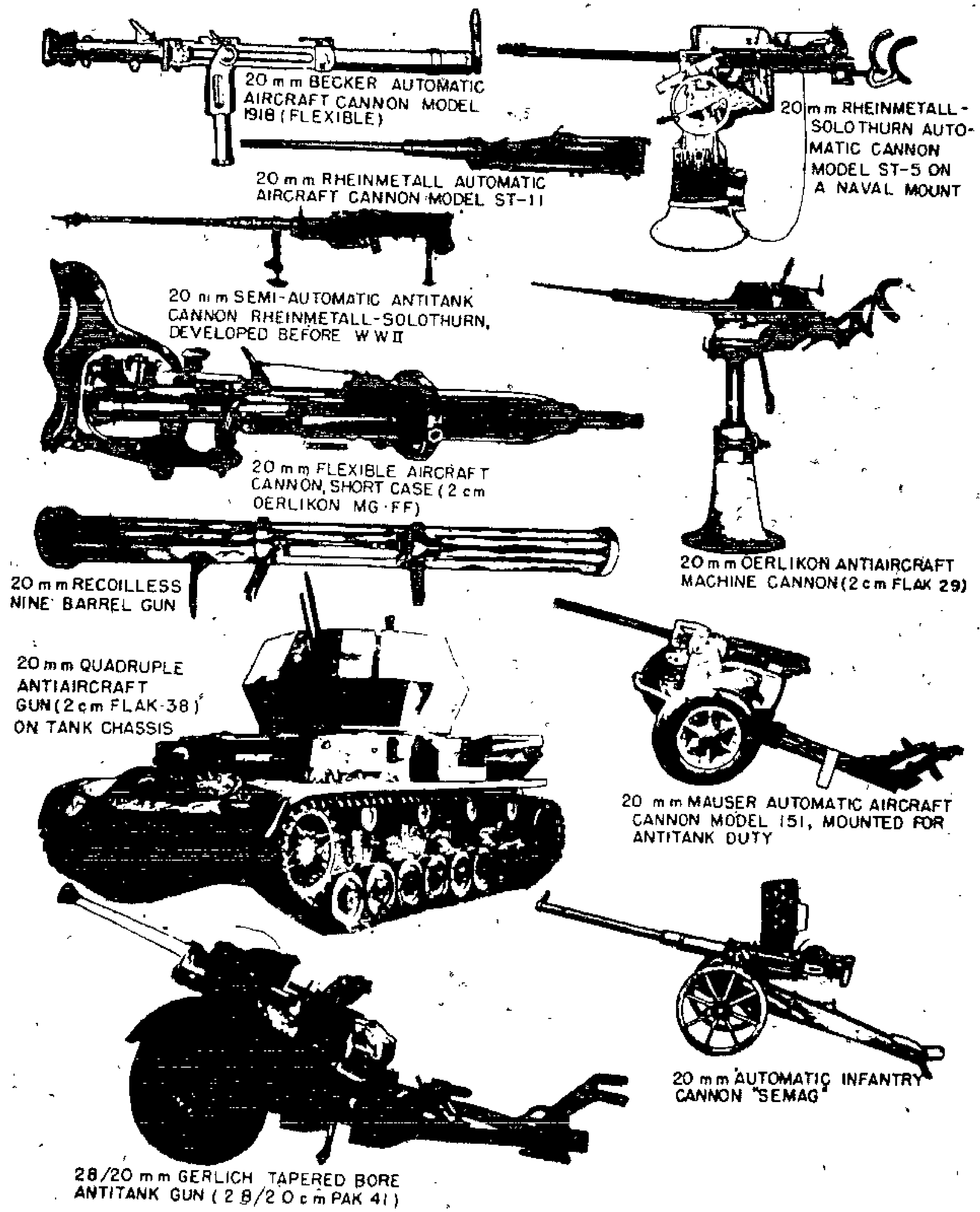
Caliber and Designation	Remarks, Uses and Some Characteristics	References
11 mm (.433") Single Shot Rifle Mauser M 1871 (Gewehr 71)	Tumbolt action; the first metallic cartridge breechloader officially adopted in Germany Wt without bayonet 10.3 lb. It used black powder	10, v 2, pp 200 & 204

Note: Previous to the Mauser M 1871, the Prussian Army (Germany did not exist as such until 1871) used the so-called Needle Gun (Zündnadelgewehr) invented in 1836 by a gunsmith Nicolas von Dreyse (1787-1867) and officially adopted in 1842. The rifle was the world's first successful tumbolt action breechloader. In its improved forms it was used successfully in the wars of 1866 (against the Austrians) and in 1870-71 (against the French). It fired a conical bullet (caliber 15.43 mm) encased in a papier-mâché cartridge together with a charge of black powder.
References: a) W.W.Greener, The Gun, Cassell, Petter & Galpin, London (1881), pp 199-200
b) Encyclopedia Britannica, London, vol 16 (1952), p 190

11 mm Rifle Model 1884 (Gewehr 84) was developed by Mauser and a German Army Commission	A slightly shorter and lighter Model 1871 altered to take a tubular magazine with a capacity of 8 rounds. It used black powder	10, v2, p 204
11 mm Revolver, German Service M 1880. Although obsolescent it was used by the Armed Forces as late as WW II	It used a cartridge contg ca 20 grains of black powder and a lead bullet weighing 210 gr	10, v1, pp 467-8 and Ref 12
11 mm French Parabellum Pistol	Used French ball ammo	5a, p 8
11 mm French Rifle 1879/83	Used French ball ammo	5a, p 8
12.7 mm (.50") Maxim Machine Gun T u F (Tank und Flieger) for use in tanks and aircraft. One of the secret weapons of WW I. About 6000 were produced in 1918 but none was used in combat	Short recoil-operated and cooled by air or water. Wt (with feed) 84 lb, rate of fire 400-450 rpm and mux vel 2750 ft/sec. Used British, German, Italian and Russian ammo	5a, p 8 and 8, v 1 pp 515-16 & 664
13 mm (.512") Tuf-Mauser A/T Machine Gun, Mod 1918	Can be seen at the Aberdeen Proving Ground (Listed as a 13.2 mm weapon)	3, p 211 and Ref 12
13 mm AC Machine Gun, MG-131, developed in 1938 by the Rheinmetall-Borsig	Short recoil operated and air-cooled. Wt (with feed) 40 lb, rate of fire 850-960 rpm and mux vel 2560 ft/sec	8, v1, pp 457-60 & 662
13 mm Solothurn Machine Gun	Used HE, HEI-T, AP-T and T ammo	9, p 543
13.2 mm (.52") French Machine Gun [13.2 mm MG 271 (f)]	Used French, Belgian and Polish ammo	5a, p 9
13.9 mm (.55") British Machine Gun	Used British AP ammo [13.9 mm Patr SmK 895 (e)]	5a, p 8
14.5 mm (.571") Russian A/T Rifle, Panzerabwehrbüchse 784 (r)	Used AP-Inc and SAP Russian ammo	5a, p 13
15 mm (.590") Machine Gun MG-151/15, Antiaircraft, Triple Pedestal Mount	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
15 mm Mauser Machine Gun (15 mm MG-151, Mauser)	Used HE-T, HE-T(SD), HEI-T(SD), AP-T, AP Tungsten core and T ammo	5a, p 9, 9, p 543 & Ref 12
15.43 mm (.607") Needle Gun M 1862 (See Note under 11 mm Single Shot Rifle)	Can be seen in the Museum of Aberdeen Proving Ground, Md	12
20 mm (.787") Czakats Automatic AC Cannon, Models CZA-1, CZA-2, CZB CZC. Developed during WW I by a Polish engineer G.Sczakats but never used in combat	Blowback-operated and air-cooled. Wt (with feed) 91 lb, rate of fire 400-450 rpm and mux vel 1500 ft/sec	8, v 1, pp 523-5 & 668
20 mm (.787") Becker Automatic AC Cannon, developed in 1918	Blowback-operated and air-cooled. Wt (with feed) 66 lb, rate of fire 300-350 rpm and mux vel 1570 ft/sec	8, v 1, pp 512 & 666 and Ref 12
20 mm Ehrhardt Automatic AC Cannon, developed at the end of WW I	Short recoil-operated and air-cooled. Wt (with feed) 160 lb, rate of fire 250-300 rpm and mux vel 2200 ft/sec	8, v 1, pp 550 & 666
20 mm Lübbe AC Cannon, invented in 1929 by H.Lübbe but not accepted by the German Govt	Operated by gas-actuated piston and cooled by air. Wt (with feed) 107 lb, rate of fire 360 and mux vel 2650 ft/sec	8, v 1, pp 548-9 & 666
20 mm Rheinmetall-Solothurn Automatic Cannon, MK-ST-5, a Naval Mount, developed before WW II	No characteristics given	8, v 1, pp 551-2
20 mm Rheinmetall Automatic AC Cannon, MK-ST-11, developed before WW II	Short recoil-operated and air-cooled. Wt (with feed) 118 lb, rate of fire 350-380 and mux vel 2250 ft/sec	8, v 1, pp 553 & 668
20 mm Rheinmetall-Solothurn Semi-Automatic A/T Cannon, developed before WW II	No characteristics given	8, v 1, p 553

WEAPONS

CALIBERS 20 mm AND 28/20 mm

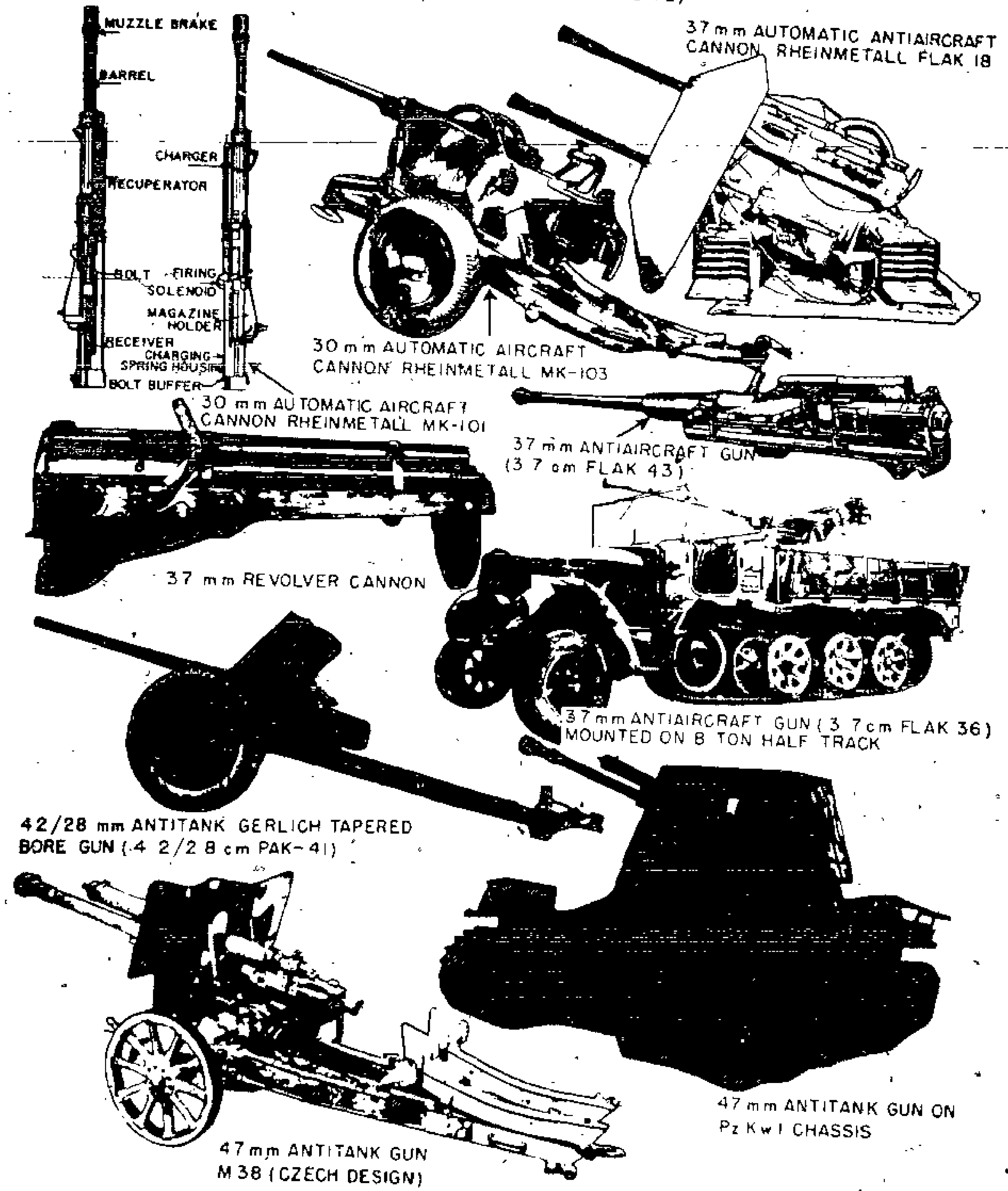


(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
20 mm Rheinmetall Automatic AA Cannon, Flak 30, developed before WW II	Short recoil-operated and air-cooled. Wt (with feed) 141 lb, rate of fire 200-280 and muz vel 2950 ft/sec. Used HE-T projectiles	5b, table 1 and 8, v 1, p 666
20 mm Oerlikon Short Case AC cannon (2 cm Oerlikon MG-FF)	Used projectiles: HE, HE (self-destroying), HEI-T, AP, APHE and API	5a, pp 44-5
20 mm Oerlikon Automatic AC Cannon, Models F and S, developed by the Oerlikon Co, Zürich and adopted by the Germans before WW II	Blowback-operated and air-cooled. Wt (with feed) 136 lb, rate of fire 280 and muz vel 2610 ft/sec	5a, p 44; 8, v 1, pp 516 & 618 and Ref 12
~~20 mm Oerlikon AA Cannon (2 cm~~ Flak 28)	Used AP, AP-T, HE, HE-T, HEI-T and HE-T self-destroying projectiles	5a, p 43
20 mm Oerlikon AA Cannon (2 cm Flak 29)	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
20 mm Mauser Automatic AC Cannon, Model 151 (MG-151), developed before WW II by the Waffenfabrik Mauser A-G	Short recoil-operated and air-cooled. Wt (with feed) 93½ lb, rate 700-750 and muz vel 2590 ft/sec. Called by Smith (Ref 9) one of the most remarkable AC MGs in existance	5a, p 45; 8, v 1, pp 602-4 & 666; 11, p 501 and Ref 12
20 mm Mauser Automatic AA Cannon, Flak 38	Short recoil-operated and air-cooled. Wt (with feed) 123 lb, rate of fire 420-480 and muz vel 2950 ft/sec	8, v 1, pp 605-6 & 666 and Ref 12
20 mm Dutch A/T Rifle [2 cm PzB 785 (h)]	Used Dutch AP and HE ammo	5a, p 13
20 mm French Machine Gun [2 cm MG 39 (f)]	Used French HE shell, type 39	5a, p 13
20 mm Solothurn Cannons: 2 cm KwK 30, 2 cm KwK 38 2 cm Flak 30, 2 cm Flak 38 2 cm Flak Vierling 38, 2 cm GebFlak 38 and Italian 2 cm M 35 (i)	Used ammunition: HE, HEI, HEI-T HE-T, HE-T (self-destroying, HE (Italian), AP, AP-T, API-T, AP-T (self-destroying), AP-T (irritant) and AP (Italian)	5a, pp 43-4
20 mm Mauser Machine Gun, MG-213, developed during WW II	Not described here because the reference is confidential	8, v 3, pp 44-51
20 mm Recoilless Cannon (9 barrels)	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
20 mm and 25 mm Semag Automatic Cannon for Infantry (Mounted on a wheeled carriage)	Developed in 1921 and 1923 but not adopted in Germany because it was considered to be too heavy. A number of Semags were sold before 1930 to China and to Spain	8, v 1, pp 514-15
25 mm (.984") French AA Gun [2.5 cm Flak Hotchkiss (f)]	Used French HE and HE-T shells	5a, p 14 and Ref 12
25 mm French A/T Guns: 2.5 cm Pak 112 & 113 (f) and 2.5 cm KwK 121 (f)	Used French AP type 114 shell	5a, p 14
27 mm (1.063") Signal Pistol (Kampfpistole), Modified	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
28/20 mm (1.102/0.787") Tapered Bore A/T Rifle (sPzBü 41), called also Squeeze Bore or Gerlich Gun	Used ammo: HE (2.8 cm Sprgr Patr 41) and AP (Pzgr Patr 41)	5a, p 14; 9, p 371 and Ref 12
30 mm (1.181") Mauser Machine Gun, MK-213C, developed during WW II	Not described here because Ref 8, v 3 is confidential	8, v 3, p 44
30 mm Rheinmetall Automatic AC Cannon, MK-101, developed in 1942	Short recoil-operated and air-cooled. Wt (with feed) 335 lb, rate of fire 230-260 and muz vel 2950 ft/sec	8, v 1, pp 555-61 & 666-8
30 mm Rheinmetall Automatic AC Cannon MK-103, developed in 1943	Operated by gas-actuated piston and air-cooled. Wt (wit' feed) 308 lb, rate of fire 420 and muz vel 2820 ft/sec	8, v 1, pp 555-61 666-8 & Ref 12
30 cm Rheinmetall Automatic AC Cannon MK-108, developed in 1944	Blowback-operated and gas-cooled. Wt (with feed) 135 lb, rate of fire 400-450 and muz vel 1640 ft/sec	as above
30 mm Automatic Recoilless Cannons, SG-116, SG-117 and SG-118, developed during WW II by the H.Göring Werke	Not described here because the reference is confidential	8, v 3, pp 630-31
30 mm Solothurn AC Cannon (3 cm Flzg K)	Used HE and AP ammo: 3 cm Sprgr and 3 cm Pzgr 40	9, p 379
30 mm Aircraft Machine Cannon, MK-303	Can be seen at the Museum of Aberdeen Proving Ground, Md	12

WEAPONS

(CALIBERS 30 mm TO 47 mm INCLUSIVE)

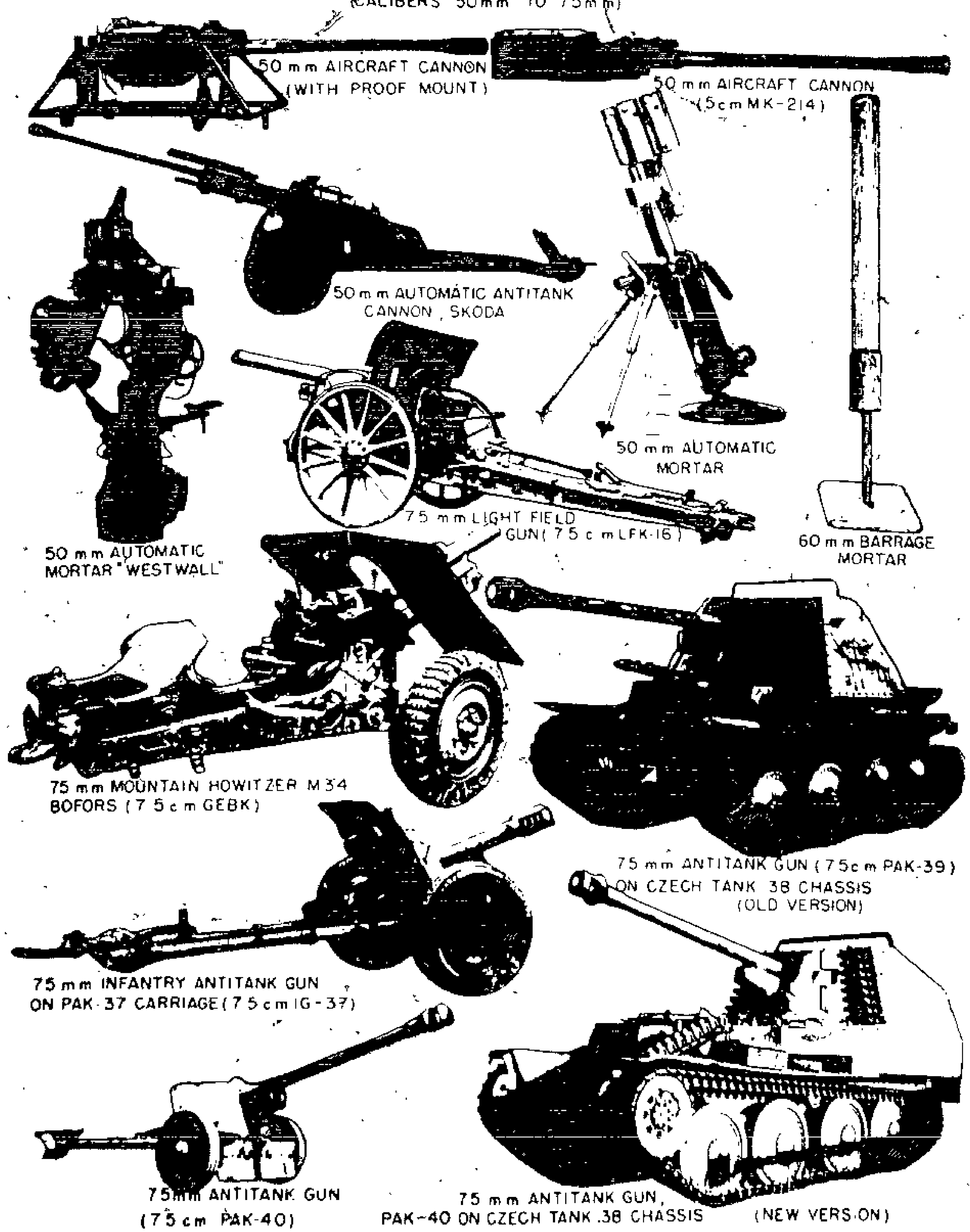


(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
37 mm (1,457") Rheinmetall Automatic AA Cannon, Type 18 (3 cm Flak 18), developed prior to WW II by Rheinmetall-Borsig A.-G	Short recoil-operated and air-cooled. Wt (with feed) 595 lb, rate of fire 160-180 and muz vel 2520 ft/sec. Used projectiles: HE, HEI, HEI-T, HE (high capacity) and AP	8, v 1, pp 554 & 666; 5a, pp 45-6 & 9, p 384
37 mm AA Cannons: 3.7 cm Flak 36, Flak 37 and Flak 43	Used ammo HE (3.7 cm Sprgr Patr 18), HE, high capacity (Mingr Patr 18), HEI (Br Sprgr Patr 18), HEI-T (BrSprgrPatr 18 L'spur) and AP, without cap (PzgrPatr 18)	5a, pp 45-6; and 9, p 384
37 mm A/T Cannon (3.7 cm Pak)	Used: AP proj with core, arrowhead design (3.7 cm PzgrPatr 40); AP proj without cap (PzgrPatr) and HE proj 18 modified (SpgrPatr 18 umg)	5a, p 15 and 9, pp 373 & 386
37 mm A/T Cannon, Fixed Defence (3.7 cm Pak K)	Used ammo: HE (3.7 cm SprgrPatr) and AP (PzgrPatr 18 umg)	5a, p 15
37 mm Naval Gun: 3.7 cm SK C/30	Used ammo: HE(3.7 cm SprgrPatr 40) and HE-T (SprgrPatr L'spur)	5a, p 15 and 9, pp 382 & 388
37 mm Naval Gun: 3.7 cm SK C/36	Used HE projectiles	5b, table 1
37 mm Tank Gun: 3.7 cm KwK	Used ammo: HE (3.7 cm SprgrPatr 18 umg & SprgrPatr 40), HE-T (SprgrPatr 18 L'spur), AP (PzgrPatr & PzgrPatr 40) and Stick grenade (Stielgr 41)	5a, p 35
37 mm A/T Gun: 3.7 cm Pak 42	Used stick (rodded) bomb: 3.7 cm Stielgr 41	9, p 383
37 mm Czech A/T Gun: 3.7 cm Pak 37 (t)	Used Czech ammo: HE (3.7 cm SprgrPatr 34), AP (PzgrPatr 34, 37, 37 umg & 40/37) and Stick Grenade (Stielgr 41)	5a, p 16
37 mm Czech Tank Gun: 3.7 cm KwK 38 (t)	Same as above	5a, p 36
37 mm French Tank Guns: 3.7 cm KwK 143 (f) (lang) and 144 (f) (kurz)	Used French HE and AP ammo: 3.7 cm SprgrPatr 145,147,148 (f) and PzgrPatr 145 & 146 (f)	5a, p 35
37 mm French Light Gun: 3.7 cm LK 152 (f)	No description given	5a, p 59
37 mm Russian Infantry Howitzers: 3.7 cm IG 145 & 146 (r)	No description given	5a, p 59
37 mm Polish A/T Gun, called by the Germans 3.7 cm Pak (p)	Used Polish design AP proj: 3.7 cm Pzgr (p)	9, p 382
37 mm Cannons: Flak 36, Pak 37, Flak 43, Revolver Cannon and AC Cannon (used in Stuka aircraft)	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
40 mm (1.575") AA Gun, Type 28 (4 cm Flak 28)	Used ammo: HE (4 cm SprgrPatr Lb 28), HE-T (SprgrPatr L'spur), HEI (BrSprgrPatr) AP (PzgrPatr, 18) and AP-T(PzgrPatr L'spur)	5a, p 46 and 9, pp 388-9
42/28 mm (1.654/1.102") Tapered Bore Gun 41 (4.2/2.8 cm lPak 41), called also Gerlich Gun or Squeeze Bore Gun	Used ammo: HE (4.2 cm SprgPatr lPak 41) and AP with core (PzgrPatr)	5a, p 46 and 9, pp 388-9
44.5 (1.75") mm Recoilless Grenade Discharger Panzerfaust 30, klein (Armored Fist, type 30, small) formerly called Faustpatrone 1, (Fist Cartridge, type 1) and a larger model Panzerfaust 30, formerly called Faustpatrone 2	Smooth-bore tube, 1.75" diameter and 31.5" long which fired a hollow charge A/T missile, resembling in appearance a rodded hand grenade. Projectile available at Museum of Picatinny Arsenal is 19⅓" long of which the warhead is 9⅓" long and the finned cylindrical body is 10". Diameter of warhead is 5⅓" and of body 1¼"	9, pp 339-40, 11, p 522, and Ref 13
Note: Later models of weapon were called Panzerfaust 60 and Panzerfaust 100 (See description under Faustpatrone)		
45 mm (1.772) Russian A/T Guns: 4.5 cm Pak 184 u 184/1 (r)	Used Russian HE and AP ammo	5a, p 17
45 mm Russian Tank Guns: 4.5 cm KwK 184/2, 184/3 & 184/4 (r)	Used Russian HE and AP ammo	5a, p 17
45 mm Russian Infantry Howitzer: 4.5 cm IG 186 (r)	No description, given	5a, p 59
45 mm Italian Mortar: 4.5 cm GrW 176 (i)	Used HE bomb; Wgr (i)	5a, p 26
46 mm (1.811") Polish Mortars 4.6 cm GrW 31 (p) and GrW 36 (p)	No description given	5a, p 26

WEAPONS

CALIBERS 50mm TO 75mm



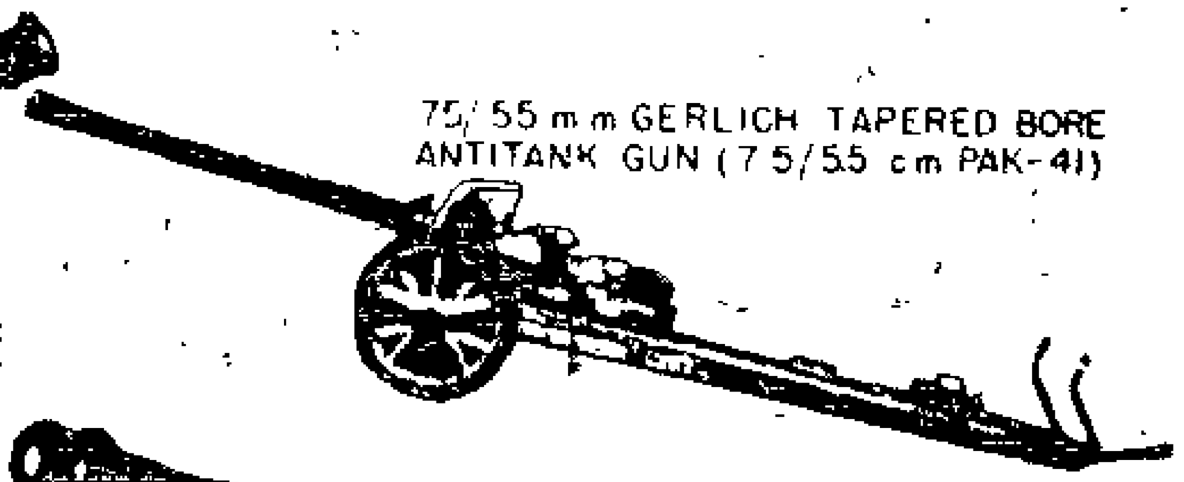
(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
47 mm (1.850") Austrian "Böhler" Gun [4.7 cm Böhler K(ö) or 4.7 cm Pak Böhler (ö)]	Used Austrian design AP and HE ammo: 4.7 cm PzgrPatr 35 (ö) and SprgrPatr (ö)	5a, p 17 and 9, pp 391-2
47 mm Belgian A/T Gun [4.7 cm Pak 185 (b)]	Used Belgian HE and AP ammo	5a, p 17
47 mm Czech Guns: 4.7 cm K 36 (t), Pak Skoda 1936 (t) and Flak 37 (t)	Used Czech design HE and AP ammo: 4.7 cm SprgrPatr 36 (t), PzgrPatr 36 (t) and Flak 37 (t)	5a, p 18, 9, pp 390-2 & Ref 12
47 mm French A/T Gun [4.7 cm Pak 18 u 183 (f)]	Used French HE and AP ammo: 4.7 cm SprgrPatr and PzgrPatr	5a, p 17
47 mm French Tank Gun: 4.7 cm KwK 173 (f)	Used French HE and AP ammo: 4.7 cm SprgrPatr 175 (f) and PzgrPatr 176 (f)	5a, p 36
47 mm Italian A/T Gun [4.7 cm Pak 177 (i)]	Used Italian HE and AP ammo	5a, p 17
50 mm (1.9685") Tank Gun: 5 cm KwK	Used ammo: HE (5 cm SprgrPatr 38), AP (PzgrPatr 39, 40 & 40/1) and Stick grenade (Stielgr 42)	5a, pp 36-7 and 9, pp 376 & 395-5
50 mm Tank Gun 38: 5 cm KwK 38	Used AP ammo: 5 cm PzgrPatr	9, p 395 & Ref 12
50 mm Long Tank Guns: 5 cm KwK 39 (L/60), KwK 39/1 and KwK 39/2 (L/60)	Used ammo: HE (5 cm SprgrPatr 38), AP (PzgrPatr 39, 40 & 40/1) and Stick Grenade (Stielgr 42)	5a, p 37
50 mm Tank Guns: 5 cm KwK 40 and KwK L/42	Used ammo: HE (5 cm SprgrPatr 38), AP (PzgrPatr 39, 40 & 40/1) and Stick Grenade (Stielgr 42)	5a, pp 36-7
50 mm A/T Gun 38 (5 cm Pak 38)	Used ammo: HE (5 cm SprgrPatr 38) and stick grenade (Stielgr 42)	5a, p 18
Note: According to Ref 5b table 1, this gun existed in 50 and 60 caliber lengths and was designated as 5 cm Pak(L/50) or 5 cm Pak(L/60)		
50 mm A/T Casemate and Turret Gun, long mount [5 cm Pak KûT (LgL)]	Used ammo: HE (5 cm SprgrPatr 38), AP (PzgrPatr 39, 40 & 40/1) and stick grenade (Stielgr 42)	5a, p 19
50 mm A/T Casemate and Turret Gun, short mount [5 cm Pak KuT (KzL)]	Used ammo: Short HE (Kz 5 cm SprgrPatr 38) and Short AP [Kz 5 cm PzgrPatr f Pak KuT (KzL)]	5a, p 19
50 mm Light Mortars: 5 cm GrW 36 and GrW M/19	Used HE mortar ammo such as: 5 cm WgrPatr 36, 39 & 41	5a, pp 26-7 and 9, pp 530-1
50 mm AA Gun 41 (5 cm Flak 41)	Used ammo: HEI-T (5 cm Br SprgrPatr 41 L'spur), HE-T (SprgrPatr L'spur), AP (PzgrPatr 39 & 42) and AP-T (PzgrPatr 42 V)	5a, p 46 and 9, p 395
50 mm Automatic Aircraft Cannon (5 cm BK) developed during WW II by the Rheinmetall-Borsig A-G	No description is given here because Ref 8, v 3 is confidential	8, v 3, p 638
50 mm Automatic AC Cannon, MK-214	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
50 mm AC Cannon	Same as above	12
50 mm A/T Automatic Cannon, Skoda	Same as above	12
50 mm Automatic Mortar (Westwall)	Same as above	12
50 mm Belgian Light Mortar. 5 cm GrW 201 (b)	Used various mortar ammo: Belgian, French, German and Russian	5a, p 26
50 mm French Light Mortar: 5 cm GrW 203 (f)	Same as above	5a, p 26
50 mm Russian Light Mortar: 5 cm GrW 205 (r)	Same as above	5a, p 26
50.8 mm (2") British Mortar: 5 cm GrW 202 (e)	Used British HE and smoke bombs	5a, p 27
55 mm (2.165") Aircraft Automatic Cannon, MK-112, developed near the end of WW II by the Rheinmetall-Borsig A-G	Not described here because Ref 8, v 3 is considered confidential	8, v 3, pp 614 & 627
55 mm Automatic Cannon, MK-114, not fully developed during WW II	Same as above	8, v 3, p 636
55 mm Automatic Recoilless Cannon, MK-115, developed by Rheinmetall-Borsig A-G but not put into production	Same as above	8, v 3, p 637

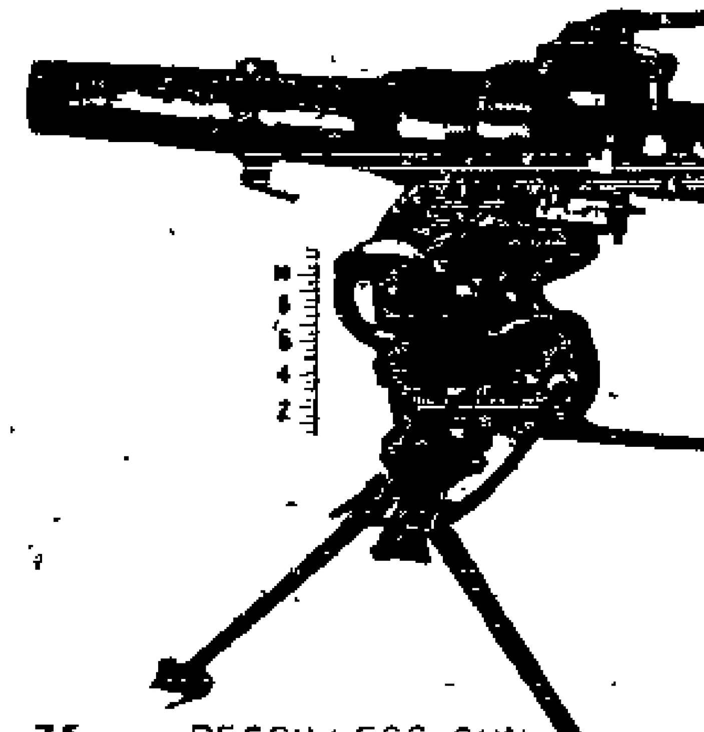
WEAPONS

(CALIBER 75 mm)

75 mm ASSAULT GUN [7.5 cm STUK (L/48)] ON PzZw IV CHASSIS

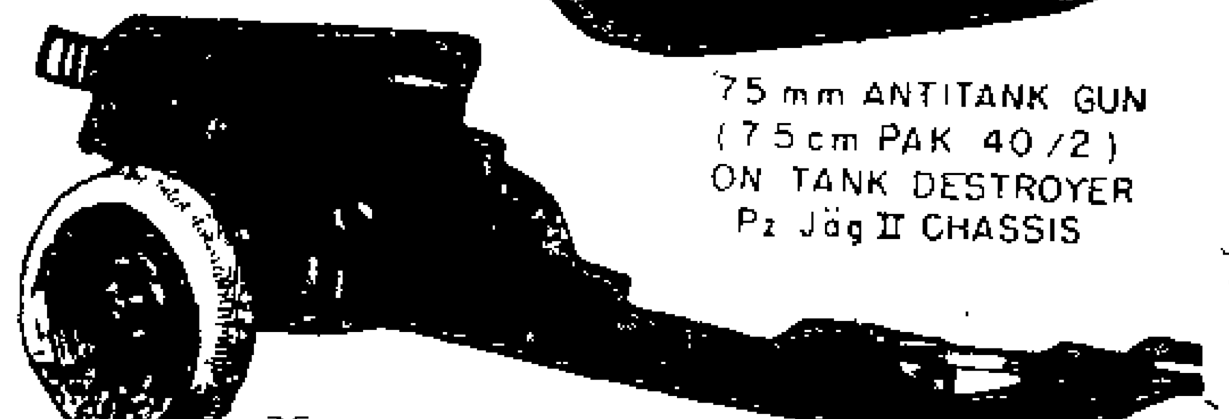


75/55 mm GERLICH TAPERED BORE ANTITANK GUN (7.5/5.5 cm PAK-41)

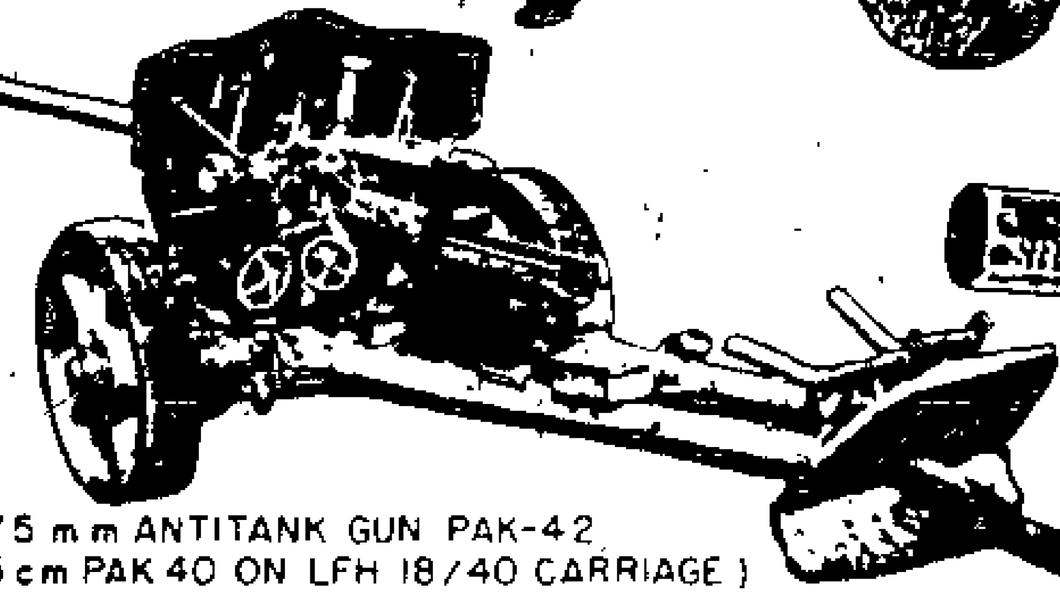


75 mm RECOILLESS GUN (7.5 cm LG-40) ON TRIPOD

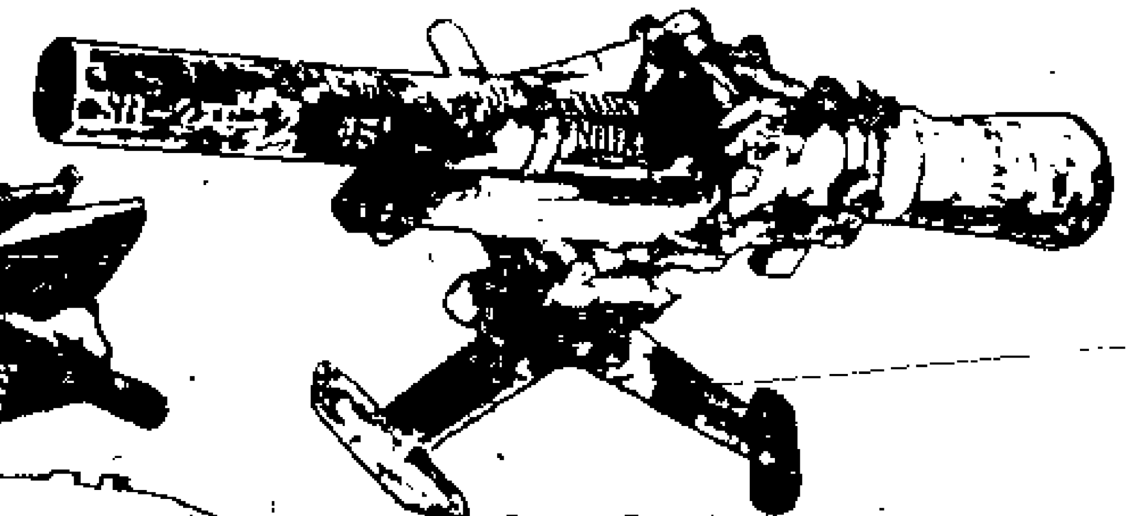
75 mm ANTITANK GUN (7.5 cm PAK 40/2) ON TANK DESTROYER Pz Jäg II CHASSIS



75 mm INFANTRY HOWITZER (7.5 cm IH-42) SMOOTH BORE

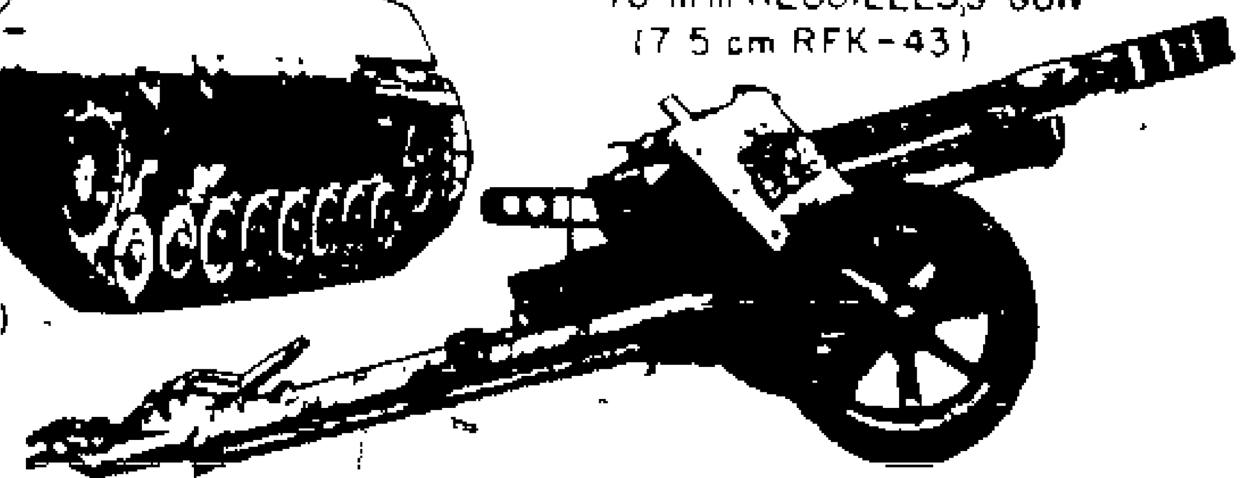


75 mm ANTITANK GUN PAK-42 (7.5 cm PAK 40 ON LFH 18/40 CARRIAGE)



75 mm RECOILLESS GUN (7.5 cm RFK-43)

75 mm ASSAULT GUN (7.5 cm STUK-42) ON Pz Jäg IV CHASSIS



75 mm ANTITANK GUN (7.5 cm PAK 50) ON PAK 38 CARRIAGE (EXPERIMENTAL)

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
60 mm (2.362") French Mortar: 6 cm GrW 225 (f)	Used French HE cast steel bomb: 6 cm Stg (Stahlguss) Wgr 225 (f)	5a, p 27
60 mm Mortar Barrage	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
65 mm (2.559") French Mountain Pack Howitzer: 6.5 cm GebK 221 (f)	Used French HE shell: 6.5 cm GrPatr (f)	5a, p 52
65 mm French Quick-Firing Gun: 6.5 cm SGesch (Schnellgeschütz) 02 (f)	Used French ammo: HE [6.5 cm Gr Patr AZ & Gr Patr DoppZ (f)] and AP [Pzgr Patr (f)]	5a, p 60
65 mm Italian Mountain (Pack) Howitzer: 6.5 cm GebH 216 (i)	Used Italian ammo: HE [6.5 cm Sprgr Patr (i)] and AP [Pzgr Patr (i)]	5a, p 52
65 mm Yugoslav Mountain (Pack) Howitzer: 6.5 cm GebK 222(j)	Used Yugoslav ammo: HE[6.5 cm Sprgr Patr 222 (j)] and Shrapnel [Schr Patr 223 (j)]	5a, p 52
73 mm (2.874") Rocket Launcher, Föhn Gerät, capable of firing 35 rockets simultaneously	A 35-frame launcher with fast elevating and transverse gears. It fired 7.3 cm Raketensprenggranate or 7.3 cm Propagandasprenggranate 41	9, pp 234-6
75 mm Mountain Guns: 7.5 cm GebK 15 & GebK 14/15	Used ammo: HE (7.5 cm GebGr 15, GebGr 15 Al, GebGr 15 Rot, GebGr 39), HoC (Gr 39 Hl/A), as well as some Austrian and Czech ammo	5a, p 55 and 9, pp 399 & 403
75 mm Skoda Mountain Gun M 15: 7.5 cm GebK M 15	Same ammo as above	5a, p 55
75 mm Light Field Gun 16: 7.5 cm lFK 16	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
75 mm Field Gun 16/1: 7.5 cm FK 16/1	Used HE proj (7.5 cm KGrRotKPS) and AP proj (KGrRotPz)	9, pp 421 & 423
7.5 mm Field Gun 16, new pattern: 7.5 cm FK 16nA	Used same ammo as above, plus HoC proj (7.5 cm Gr 38 Hl/A)	5a, pp 60-1 and 9, pp 409, 421 & 423
75 mm Light Field Gun 18: 7.5 cm lFK 18	Used ammo: HE (7.5 cm Sprgr Patr 34 & KGrRotKPS), AP (KGrRotPz), APC (PzGrPatr 38), HoC (Gr 38 Hl/A & GrPatr 38 Hl/A) and Smoke (Nbgr Patr)	5a, pp 61-2 and 9, pp 400-3, 407, 409, 421 & 423
75 mm AA Cannon 18: 7.5 cm Flak 18	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
75 mm Light Infantry Howitzer 18: 7.5 cm lJH 18	Used ammo: HE (7.5 cm Jgr 38 FES) and HoC (Jgr 38 Hl/A and Hl/B)	9, pp 413, 418 & 425 and Ref 12
75 mm Light Mountain Infantry Howitzer 18: 7.5 cm lGebJH 18	Used same projectiles as previous weapon	9, pp 413, 418 & 425
75 mm Light Infantry Guns: 7.5 cm lJG 18, 37 & 42	Used ammo: HE (7.5 cm Jgr 18, Jgr 18 Al), HoC (Jgr 38 Hl, Jgr 38 Hl/A, Jgr Patr Hl/A, Jgr 38 Hl/B) and indicating shell (Jgr Deut)	5a, p 30; 9, p 404 and Ref 12
75 mm Light Infantry Mountain Gun: 7.5 cm lGebJG 18	Same as above	5a, p 30 and 9, pp 404-5
75 mm Heavy Infantry Guns: 7.5 cm sJG 33, sJG 33/1 & sJG 42	Used ammo: HE (15 cm Jgr 33, Jgr 38 & Jgr 38 Al), HoC (Jgr 39 Hl/A & Jgr Hl/B) Stick grenade (Stielgr 42), Smoke (Jgr 38 Nb) and Inc (Jgr 38 Br)	5a, p 31
75 mm Naval Gun: 7.5 cm SK C/34 (L/33)	Used HE projectiles	5b, table 1
75 mm Mountain Howitzer Bofors: 7.5 cm GebH 34	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
75 mm Mountain Gun 36: 7.5 cm GebG 36	Used ammo: HE (7.5 cm Gr 34 Sprgr Patr 34, KGrRotAl & KGr 34 Al), HoC (Gr 38 Hl/A, Hl/B & Hl/C) and Smoke Indicator (KGrRot Deut blau & KGrRotBunt)	5a, p 52 and 9, pp 398, 401, 409 & 416
75 mm Gun 37: 7.5 cm K 37 L/24	Used ammo: HE (7.5 cm Sprgr Patr), HoC (GrPatr 38 Hl/A, Hl/B & Hl/C), AP (PzgrPatr), Case Shot (Kt Patr), Smoke (NbgrPatr) and Indicating shell (KGrPatr Rot Deut)	5a, p 38
75 mm Tank Gun: 7.5 cm KwK	Same as above	5a, p 38
75 mm Assault Gun: 7.5 cm StuG	Same as above	5a, p 38
75 mm Field Gun 38: 7.5 cm FK 38	Used ammo: HE (7.5 cm KGrPatr, Sprgr L/4.8), HoC (GrPatr 38 Hl/B & Hl/C) and Smoke Indicator (KGrPatr Rot Deut)	5a, p 62 and 9, p 415

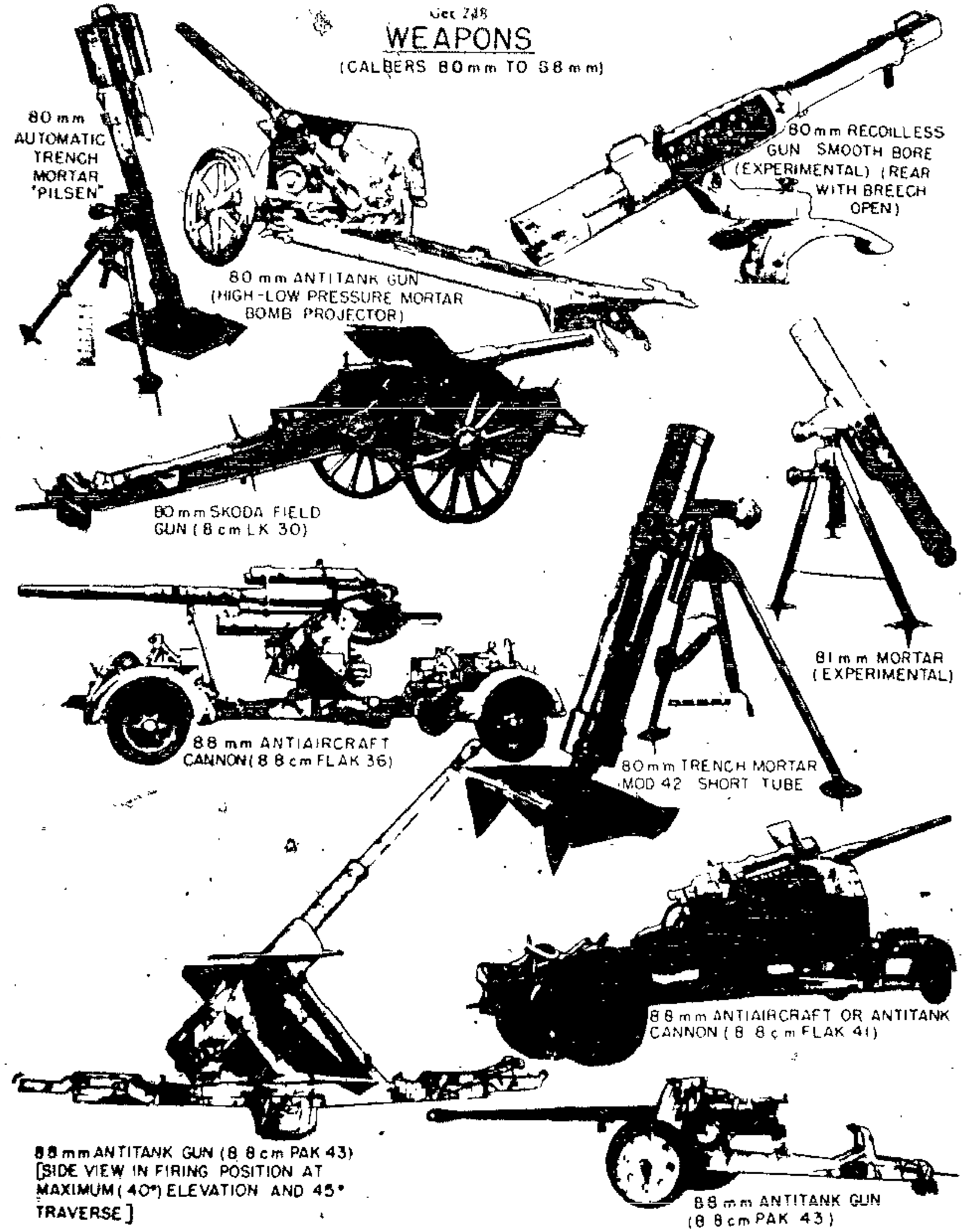
(Weapons) (Cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
75 mm Tank Gun 38: 7.5 cm KwK 38	Used HoC ammo: 7.5 cm Gr Patr 38 Hl/A	9, p 409
75 mm A/T Gun 39: 7.5 cm Pak 39 L/48	Used ammo: HE (7.5 cm Sprgr Patr 34), HoC (Gr Patr 38 Hl/A, Hl/B & Hl/C), AP (Pzgr Patr 39, Pzgr Patr 40 & Pzgr Patr W) and Smoke (Nbgr Patr)	5a, p 39
75 mm Tank Guns: 7.5 cm KwK 40 L/43 and KwK 40 L/48	Same as above	5a, p 39
75 mm Assault Guns: 7.5 cm StuK L/43 & StuK L/48	Same as above	5a, p 39
75 mm A/T Guns: 7.5 cm Pak 97/38 and 97/40	Used ammo: HE (7.5 cm Sprgr Patr), HoC (Gr Patr 15/38 Hl, Gr Patr 38 Hl, Gr Patr 38/97 Hl/A & Hl/B), AP (Pzgr Patr 39), and Star (Lt Gr Patr) and some foreign ammo	5a, p 21 and 9, pp 415, 419-20 & 425
75/50 mm Skoda Dual Purpose Gun	Used HE ammo: 7.5 cm Sprgr Patr 75/50	9, p 406
75 mm A/T Gun 40: 7.5 cm Pak 40	Used ammo: HE (7.5 cm Sprgr Patr 34 KwK, etc), HoC (Gr Patr Hl/A, Hl/B and Hl/C, etc), AP (Pzgr Patr 40, Weicheisen or Pzgr Patr 40, harter Kern) and Smoke (Nbgr Patr)	5a, p 21; 9, pp 398, 401-2, 408-9, 411 & 417 & Ref 12
75 mm Self-Propelled A/T Guns: 7.5 cm Pak 40/1 (Sf, Pak 40/2 (Sf) and Pak 40/3 (Sf)	Used HoC ammo, such as 7.5 cm Gr Patr Hl/B	5a, p 21; 9, p 411 and Ref 12
75 mm Tank Gun 40: 7.5 cm KwK 40	Used ammo: HE (7.5 cm Sprgr 34 & Sprgr Patr 34) APC (Pzgr Patr), HoC (Gr Patr Hl/A, Gr Patr Hl/B, Gr Patr 38 Hl/B & Gr 38 Hl/B), Smoke (Nbgr Patr)	9, pp 398, 400-3, 409, 411 & 417
75 mm Recoilless Gun for Airborne Troops Type 40 (7.5 cm Leichtes Geschütz 40)	Used same ammo as above, less Sprgr 34 and Gr 38 Hl/B	9, pp 398, 400-3, 409 & 411 & Ref 12
75 mm Assault Gun 40 (7.5 cm StuG 40)	Used ammo: HE (7.5 cm Sprgr Patr 34), APC (Pzgr 39 FES), HoC (Gr Patr 38 Hl/A & Hl/B, Gr 38 Hl/B & Gr Patr Hl & Hl/B) and Smoke (NbgrPatr)	9, pp 398, 400-2 & 409-11
75 mm Assault Guns: 7.5 cm StuK 40 L/43 and StuK 40 L/48	Used ammo: HE (7.5 cm Sprgr 34) and HoC (Gr 38 Hl/B)	9, pp 411 & 417 and Ref 12
75/55 mm A/T Gun 41: 7.5/5.5 cm Pak 41 [Gerlich Type Gun, called also Tapered Bore Gun, Reducing Bore Gun or Squeeze Bore Gun]	Can be seen at the Museum of Aberdeen Proving Ground, Md. Used AP proj with iron core [7.5 cm Pzgr 40 (W)] and AP proj with tungsten carbide core, arrowhead design [Pzgr Patr 41 (HK)]	5a, p 20; 9, pp 378, & 408 and Ref 12
75 mm Assault Gun 42: 7.5 cm StuK 42	Used ammo: HE (7.5 cm SprgrPatr 42), HoC (GrPatr 38 Hl) and AP (PzgrPatr 39/42, 40 & 40/42)	5a, p 39
75 mm Tank Gun 42: 7.5 cm KwK 42 L/70	Same as above	5a, p 39
75 mm Tank Gun 42: 7.5 cm KwK 42	Used ammo: HE (7.5 cm Sprgr 42) and AP (Pzgr 39/42)	9, pp 411 & 423 and Ref 12
75 mm Assault Gun 42: 7.5 cm StuK 42 L/70	Used same ammo as above	9, pp 411 & 423 and Ref 12
75 mm Infantry Howitzer 42, Smooth Bore: 7.5 cm IH 42	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
75 mm Recoilless Gun 43: 7.5 cm RFK (Rückstossfreie Kanone) 43	Can be seen at the Museum of Aberdeen Proving Ground, Md. Used HoC proj: 7.5 cm Gr Patr 43 Hl	5a, p 21 and Ref 12
75 mm A/T Gun 50, Experimental: 7.5 cm Pak 50	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
75 mm Belgian Guns: 7.5 cm FK 234 (b) 7.5 cm FK 235 (b) 7.5 cm FK 236 (b)	Used ammo: HE: Sprgr 230/7, (f) and HoC: Gr 15/38 Hl/B (f) HE: Sprgr 240/2 (b) HE: Sprgr 1900/15 (f)	5a, p 21 and 9, pp 415, 420-1 & 425
75 mm Czech AA Gun: 7.5 cm Flak (Skoda)	Used Czech HE ammo, 7.5 cm Sprgr Patr (t)	5a, p 46
75 mm Czech Field Gun 17: 7.5 cm FK 17 (t)	Used Czech HE ammo: 7.5 cm Gr M/17 & M/19 (t)	5a, p 66
75 mm Dutch Guns: 7.5 cm FK 243 (h) 7.5 cm FK 243 (h) L 30	Used ammo: HoC: Gr 38 Hl/C (h) HE: KGrRotKPS and KGrRotPz	9, pp 413, 421 & 423

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
75 mm French Guns: 7.5 cm FK 231 (f), Mle 97 7.5 cm FK 232 (f), Mle 97/33 7.5 cm GebK 238 (f), Mle 1928 7.5 cm KwK 251 (f), Mle 1935 7.5 cm Flak M 17/34 & Flak M 36	Used ammo HE: Sprgr 1900/15 (f) & Sprgr 231/1 (f) and HoC: Gr 15/38 Hl/B (f) HE: Sprgr 231/1 (f) & Sprgr 264 (j) and HoC: Gr 15/38 Hl/B (f) HE: Sprgr 231 (f) HE: Sprgr 231 (f) HE: Sprgr 28 (f)	5a, pp 21 & 41 9, pp 413-25
75 mm Field Guns: 7.5 cm FK 237 (i) & 244 (i)	Used Italian HE and Shrapnel ammo	5a, p 64
75 mm Italian Mountain Gun: 7.5 cm GebK 259 (i) (See also under Weapons in the Italian section)	Used same ammo as 7.5 cm GebK 15	5a, p 55
75 mm Norwegian Guns: 7.5 cm FK Schneider (n) 7.5 cm FK 01 (n) 7.5 cm BK L/17 (n) 7.5 cm FK 246 & 247 (n)	Used Norwegian ammo HE: GrKartå M/31 (n) and Shrapnel: GrSchr(n) HE: GrKartå M/01, M/21 & M/36(n) and HE-Inc: BrGrKartå M/13 (n) HE: GrKartå M/21 & M/36 (n); HE-Inc: BrGrKartå M/34 (n) No information available	5a, pp 55 & 65-66
75 mm Polish Guns: 7.5 cm FK 97 (p) 7.5 cm FK 02/26 (p)	Used ammo HE: Sprgr 1900/15 (f) & HoC: Jgr 38 Hl/B	5a, p 21 and 9, pp 419-20 & 423
75 mm Yugoslav Guns: 7.5 cm FK 249 (j) Mod 12 (Schneider) 7.5 cm GebK 258 (j) 7.5 cm GebK 259 (j) 7.5 cm GebK 285 (j)	Used ammo HE: Sprgr 264 (j) & Sprgr 1900/15 (f) and HoC: Gr 15/38 Hl/B (f) & Gr 38-97 Hl/C (f) Same ammo as 7.5 cm GebK 15 HE: Sprgr 249 (j) and Shrapnel (Schr 250 & 251) HE: Sprgr 260/1 & 260/2 (j)	5a, pp 21, 54-5 & 9, pp 415, 419-20 and 423
75 mm Yugoslav Mortar: 7.5 cm GrW 229 (j)	Used HE bomb: Wgr 229 (j)	5a, p 27
76 mm (2.992") British AA Gun: 7.6 cm Flak (e)	Used British HE fixed round: 7.6 cm Sprgr Patr (e)	5a, p 48
76.2 mm (3.000") Russian Guns: 7.62 cm FK 39 (r) 7.62 cm KK 290/1 and 310 (r) 7.62 cm Pak 36 (r) 7.62 cm RFK 299 (r) and many other models were captured and used by the Germans during WW II (See Weapons in the Russian section)	Used various Russian design projectiles either captured or manufactured in Germany	5a, pp 23-4, & 40-1; 9, pp 426-32
76.5 mm (3.004") Austrian Field Guns: 7.65 cm FK 5/8(ö), FK 17(ö), and FK 18(ö), manufactured by Skoda Works, Pilsen	Used Austrian and Czech design ammo	5a, p 68
76.5 mm French Field Guns: 7.65 cm FK 5/8 (f) & FK 17	Used French design ammo	5a, pp 68-9
76.5 mm Yugoslav Guns: 7.65 cm FK 300 (j), 303 (j), & 304 (j), manufactured by Skoda Works	Used Yugoslav, Czech and Austrian ammo	5, pp 68-9
77/45 mm (3.03/1.77") Recoilless Automatic Cannon, SG-113A, developed during WW II by the H.Göring Werke but not put into production	Not described here because Ref 8,v3 is confidential	8, v3, p 630
80 mm (3.15") Medium Mortar, designated 8 cm SGrW 34	Used HE mortar ammo: 8 cm Wgr 34, Wgr 38, Wgr 39 & Wgr 38 Deut)	9, pp 529, 531 & 533
80 mm Medium Mortar, designated as 7.5 cm MGrW 34	Used smoke mortar ammo (7.5 cm Wgr 34 Nb)	9, p 532
80 mm Trench Mortar, designated as 7.5 cm KzGrW 42	Used HE Mortar ammo (7.5 cm Wgr 34) and Smoke (Wgr 34Nb)	9, pp 532-3 and Ref 12
80 mm Automatic Mortar, "Pilsen"	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
80 mm A/T Gun (High-Low Pressure Mortar Bomb Projector)	Same as above	12
80-mm Smooth-Bore Weapon, called Panzerwurfkanone, developed by the Rheinmetall-Borsig Co and issued to the troops at the end of 1944	Mounted on a carriage weighing 1370 lb, it fired a finned projectile at a max vel 1700 ft/sec to an effective range of 700 meters. The shell weighed 6 lb, was 18" long and had a penetration of 140 mm at 60° angle of impact	6, p 188

WEAPONS
(CALIBERS 80mm TO 88mm)

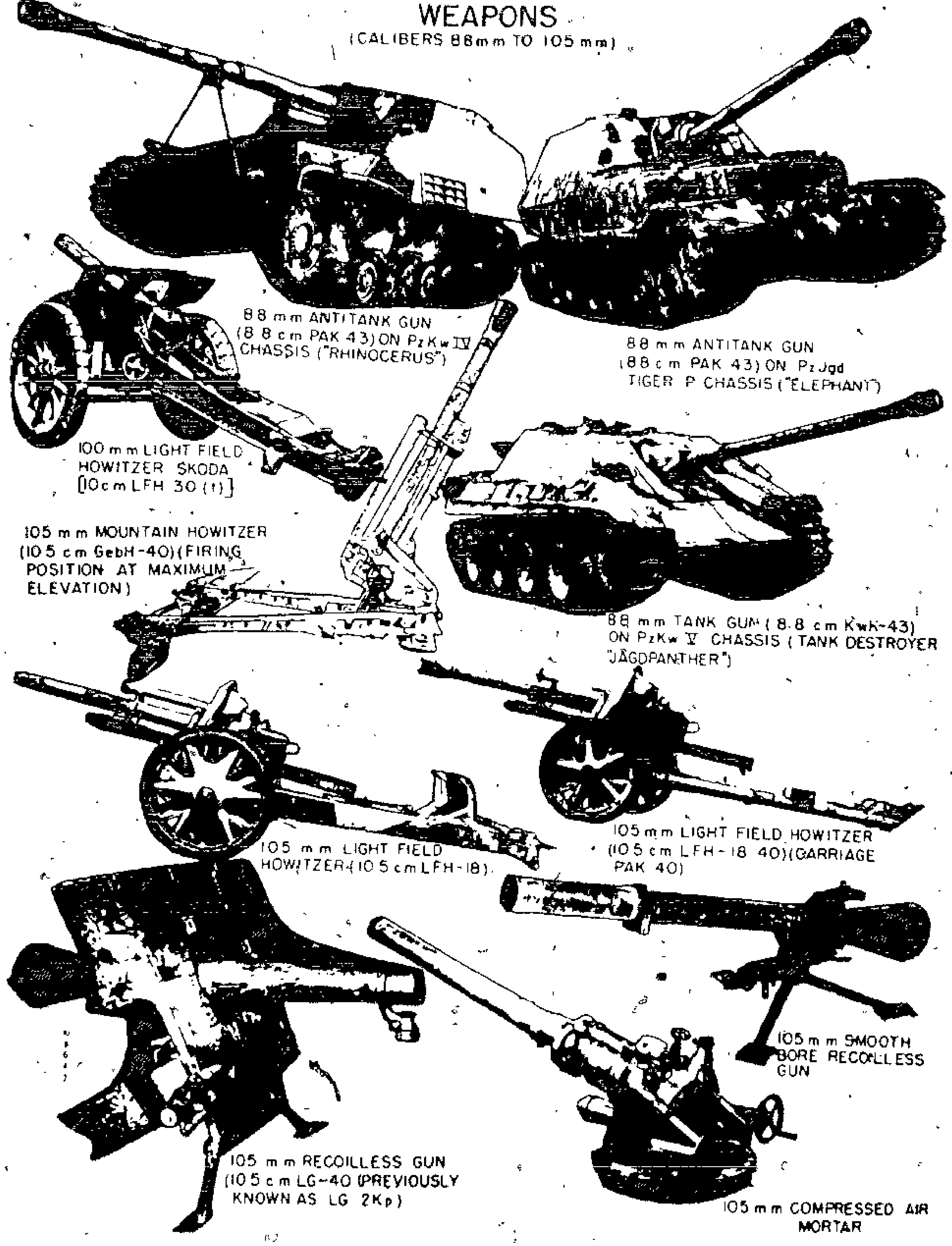


(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
80 mm Multiple-Rocket Launcher, designated as 8 cm Raketenvielfachwerfer	It fired HE aircraft rockets (8 cm Raketen Sprenggranaten), similar in construction to a standard Russian aircraft rocket	9, p 237
80 mm Trench Mortar, Short Tube, Mod 42	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
80 mm Recoilless Gun, Smooth Bore, Experimental	Same as above	12
80 mm Czech Field Gun: 8 cm FK 16/17 (t)	Used Czech HE shell, 8 cm Gr M 30/17 (t)	5a, p 69
80 mm Czech Field Gun: 8 cm FK 30 (t)	Used Czech HE and AP projectiles: Gr 30, Gr 35 and Pzgr (t)	5, p 69
80 mm Polish Mortar: 8 cm GrW 28 (p)	Used German and foreign projectiles	5a, pp 28-9
81 mm (3.19") Mortar, Experimental	Same as above	12
81-82 mm Foreign Mortars used by the Germans included: 8.1 cm GrW 274 (dan), 8.1 cm GrW 279 (h), 8.1 cm GrW 286 (b), 8.14 cm GrW 278 (f), 8.14 cm GrW 286 (f), 8.2 cm GrW 274 (r) & 274/2 (r)	Used German and foreign projectiles	5a, pp 28-9
83.5 (3.287") Czech Design AA Gun (8.35 cm Flak M/22 (t))	Used Czech design and manuf projectiles: 8.35 cm Gr 23/30 (t) and 8.35 cm Pzgr (t)	5a, p 48 and 9, p 436
83.8 mm (3.305") British Field Guns: 8.38 cm FK 271, 272 & 273 (e)	Used British HE and smoke shells: Sprgr Patr 106 and Nbgr Patr 106 (e)	5a, p 70
83.8 mm Russian Field Gun: 8.38 cm FK 305 (r)	No information given	5a, p 70
86 mm (3.386") Single Barrel Rocket Launcher, designated as 8.6 cm R Ag M 42 and weighing 40 kg	It fired various rockets used by the Navy, such as HE, flare, etc	9, p 241
86 mm Rocket Launcher (No German designation is given)	Used HE rockets, designated 8.6 cm RSprgr L/4.5 and RSprgr L/5.5	9, pp 256-7
87.6 mm (3.45") British Field Guns 280, 281 & 282 (e) (25 pounders)	Used British ammo: HE [Gr 292 & 295 (e)] and Smoke [Rauchgr (e)]	5a, p 70
88 mm (3.465") AA Gun 18: 8.8 cm Flak 18	Used ammo: HE (8.8 cm Sprgr L/4.5, Sprgr L/4.5 ZtZ & Sprgr Patr L/4.5 Kz), AP (Pzgr & Pzgr 39), APC (Pzgr Patr Bd Z) and Inc Shrapnel (Gr Br Schr Flak)	9, pp 438, 441, 444, 446 & 448
88 mm Tank Gun 36: 8.8 cm KwK 36	Used HE ammo: 8.8 cm Sprgr L/4.5	9, p 444
88 mm Naval Guns: 8.8 cm SK C/25, C/30, C/31, C/32 & C/35	Used HE and Star projectiles	5b, table 2
88 mm Torpedoboat Gun: 8.8 cm Tbts K L/45	Used HE and Star projectiles	5b, table 2
88 mm Tank Gun 36 (56 calibers long): 8.8 cm KwK 36 L/56	Used ammo: HE (8.8 cm Sprgr Patr L/4.5), HoC (Gr Patr 39 Hl), AP (Pzgr Patr 36, 39, 39/1 & 40), Shrapnel-Incendiary (Br Schr Gr Patr), and Star Shell (Lt Gesch L/4.5)	5a, p 41 and 9, pp 444-5 & 448
88 mm AA Gun 36: 8.8 cm Flak 36	Used ammo: HE (8.8 cm Sprgr L/4.5, Sprgr Patr L/4.5 Kz & Sprgr L/4.5 ZtZ), AP (Pzgr 39) and Inc-Shrapnel (Gr Br Schr Flak)	9, pp 438, 444, 446 & 448 and Ref 12
88 mm AA Gun 37: 8.8 cm Flak 37	Same as above	9, pp 438, 444 446 & 448
88 mm AA Gun 41: 8.8 cm Flak 41	Used ammo: HE (8.8 cm Sprgr Patr L/4.7 FES & Sprgr Flak 41), AP with tungsten carbide core (Pzgr 40), AP (Pzgr Patr 41) and APC (Pzgr Patr 39)	9, pp 437-9, 441 & 444 and Ref 12
88 mm AA Gun 43: 8.8 cm Flak 43	Used HE ammo: 8.8 cm Sprgr Patr (L/4.7) FES	9, p 441
88 mm Short Mortar	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
88 mm Tank Gun 43 [8.8 cm KwK 43 (L/71)]	Used ammo: AP (8.8 cm Pzgr Patr 39, 39/1, 39/43, 40 & 40/43), HoC (Gr Patr 39 Hl & 39-43 Hl) and HE (Sprgr Patr 43, etc)	5a, pp 24-5; 9, pp 442 & 447 and Ref 12

WEAPONS

(CALIBERS 88mm TO 105 mm)



(Weapons) (Cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
88 mm A/T Guns 43, 43/1, 43/2, 43/3 (8.8 cm Pak 43, 43/1, 43/2, 43/3)	Same as in 88 mm Tank Gun 43	5a, pp 24-5 and 9, pp 442 & 447
88 mm Self-Propelled Assault Gun 43 [8.8 cm StuK 43 (L/71)]	Same as above	5a, pp 24-5 and 9, pp 442 & 447
88 mm Self-Propelled A/T Guns [8.8 cm Pak 43 & Pak 43/41 (L/71)]	Same as above	5a, pp 24-5; 9, pp 442 & 447 and Ref 12
88 mm AA Gun (Converted Russian 85 mm Gun) [8.5/8.8 cm Flak 39 (r)]	Used Russian and German ammo: HE (8.8 cm Sprgr L/4.5) and AP (8.8 cm Pzgr and Pzgr 39)	9, pp 444, 446 & 448
88 mm Rocket Launcher, called Raketenpanzerbüchse 43 (8.8 cm RPzB 43), known also as Raketenwerfer 43 or Ofenrohr (Stovepipe)	This was an earlier version of the 8.8 cm RPzB described below. It had no shield. It used the same ammunition as below	5b, pp 9-13; 11, p 521
88 mm Rocket Launcher, called 8.8 cm Raketenpanzerbüchse 54 (8.8 cm RPzB 54) or Panzerschreck. It was an enlarged version of original American Bazooka. Its operation required two men. This launcher was also called Ofenrohr	Smooth-bore tube 5'4½" long and weighing 20½ lb, exclusive of shield. It fired a shaped charge rocket projectile (8.8 cm RPzBGr 4322) 23½" long and weighing about 7 lb, which penetrated steel armor about 4½". Its range was 55 to 165 yd and muzzle velocity up to 3280 ft/sec. The launcher was provided with a projectile guide which wore out after firing 300 rounds	5a, p 10, 6, p 188, 7, p 23, 9, pp 243-6, 11, pp 521-2 and Ref 13

Note: This weapon was provided with a simple electric generator which produced the necessary spark to ignite the propelling charge in the rocket. The original American Bazooka used flashlight batteries for producing a spark. When the projectile was launched the back blast of flame reached a length of about 16 ft (See also description of Faustpatrone, called later Panzerfaust)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
88 mm Rocket Launcher Püppchen; designated as 8.8 cm Raketenwerfer 43 (8.8 cm RW 43), known also as "Wheeled Bazooka". The projectile was the same as above except that is was modified for percussion firing	It was essentially the Panzerschreck mounted on a light carriage. The total weight of launcher was 340 lb and the effective range 200 yd. This model was discontinued before the end of WW II	5, p 188, 6, p 199, 9, p 245 and 11, p 522
90 mm (3.54") French AA Gun: 9 cm Flak (f)	No other information given	5a, p 49
90 mm Yugoslav Mortar, 9 cm GrW 309 (j)	Used Yugoslav HE mortar bomb: 9 cm Wgr 309 (j)	5a, p 30
94 mm (3.7") British AA Gun: 9.4 cm Flak (e)	Used British HE ammo: 9.4 cm SprgrPatr (e)	5a, p 50
94 mm British Pack Howitzer: 9.4 cm GebH 301 (e) (Mountain Howitzer)	Used British HE ammo: 9.4 cm Sprgr mAZ (e)	5a, p 56
100 mm (3.937") Guns 17 and 17/04, new design: 10 cm K 17 & 17/04nA	Used ammo: HE (10 cm FHGr & Gr 15 Hb) and AP (Pzgr)	5a, p 79
100 mm Heavy Gun 18: s10 cm K 18	Used ammo: HE (10 cm Gr 19), AP (Pzgr) and Smoke (Gr 38Nb)	5a, p 80
100 mm Light Field Howitzer 18: 10 cm lFH 18	Used HoC ammo: 10 cm Gr Rot Hl/B and Hl/C	9, pp 450-1 and Ref 12
100 mm Casemate and Turret Guns (Medium): m10 cm KK and KT	Used ammo: HE (m10 cm GrPatr 34), AP (PzgrPatr) and Case Shot (KtPatr)	5a, p 79
100 mm Long Turret Gun: Lg 10 cm KT	Used ammo: HE (10 cm Gr 19), AP (Pzgr), Smoke (Gr 38Nb) and Case Shot (Kt)	5a, p 81
100 mm Chemical Projector (Smoke Shell Mortar): 10 cm NbW 37	Used HE mortar ammo: 10 cm Wgr 37	9, p 533
100 mm Rocket Launcher: 10 cm "Panzerschreck"	An enlarged version of 88 mm Panzerschreck	6, p 188
100 mm Guns 18/40 and 42: 10 cm K 18/40 & K 42	No description given	5a, p 80
100 mm Austrian Mountain Howitzer (Pack Howitzer): 10 cm GebHaub M/16 (ö)	Used Austrian ammo: HE (10 cm GebGr M/32 and Smoke (GebGr M/32Nb)	5a, p 57
100 mm Light Czech Field Howitzers: 10 cm lFH 14/19 (t) and lFH 30 (t)	Used Czech HE ammo: 10 cm Gr 15, 21 & 30	5a, p 78 and 9, pp 451-5
100 mm Italian Light Field Howitzers 10 cm lFH 315 (i)	Used Italian HE ammo: 10 cm Sprgr 315 (i)	5a, p 77

(Weapons) (cont'd)

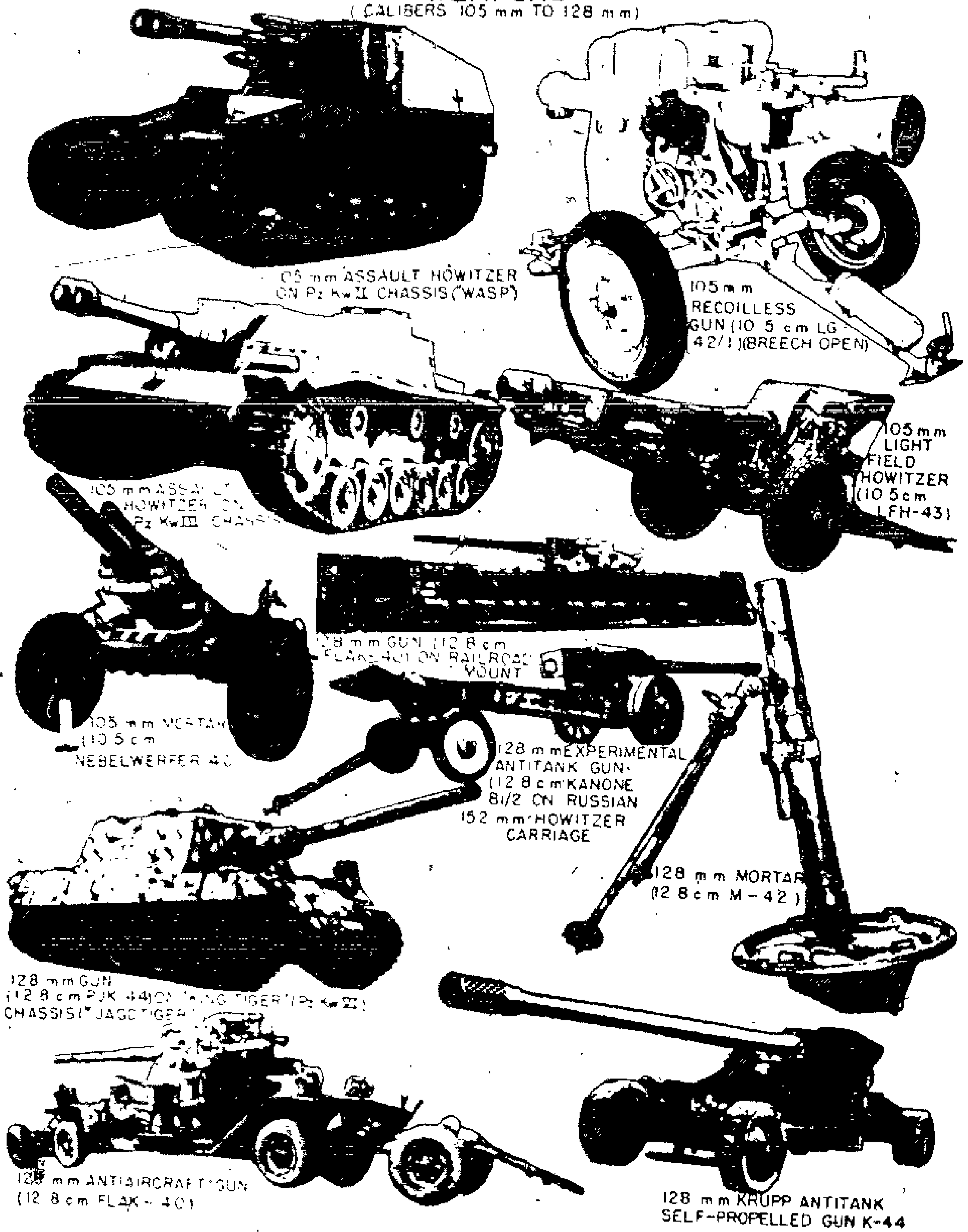
Caliber and Designation	Remarks, Uses and Some Characteristics	References
100 mm Polish Light Field Howitzer: 10 cm lFH 14/19 (p)	Used Polish HE steel shell: 10 cm Stgr (p)	5a, p 78 and 9, pp 451-5
100 mm Yugoslav Light Field Howitzers 10 cm lFH 315 (j), 316 (j), 317 (j), 317/1 (j) & 317/2 (j)	Used Yugoslav ammo: HE (10 cm Sprgr 310, 311 & 315) and Shrapnel (Schr 316 & 317)	5a, pp 76-8 and 9, pp 451-5
105 mm (4.134") Light Field Howitzer 16: 10.5 cm lFH 16	Used ammo: HE (10.5 cm FHGr, FHGrStg, FHGr 38, FHGr 38 Stg FES), HE-I (FHGrSprBr), AP (Pzgr Rot L'spur), HoC (Gr 39 Rot Hl, Gr 39 Rot Hl/A, Gr 39 Rot Hl/B & Gr 39 Rot Hl/C) and Smoke (FHGrNb, FHGr 38 Nb and FHGr 40 Deut)	5a, p 71 and 9, pp 457, 461 & 470-6
105 mm Guns 17 and 17/04 new pattern: 10.5 cm K 17 & K 17/04nA	Used HE ammo: 10.5 cm FHGr Rot	9, p 457
105 mm Medium Heavy Gun 18: 10.5 cm sK 18	Used ammo: HE (10.5 cm Gr 19 & Gr 19 Kz 13) and AP (Pzgr Rot)	9, pp 456, 468 & 481
105 mm Light Field Howitzers: 10.5 cm lFH 18, lFH 18mM, lFH 18/1, lFH 18/2, lFH 18/39 & lFH 18/40	Used ammo: HE (10.5 cm FHGr, FHGrStg, FHGr 35, FHGr 38, FHGr 38 Stg FES, FHGr 38Kh, FHGr 39, Sprgr 43 PG Sprgr 42 Ts, MinGr and FHGr F), HEI (FHGr SprBr), HoC (Gr 39 Rot Hl, Gr 39 Rot Hl/A, Gr 39 Rot Hl/B & Gr 39 Rot Hl/C), AP (Pzgr mBdZ, Pzgr Rot & Pzgr 39TS), Smoke (FHGrNb, FHGrNb 38 FES, FHGrNb 39, FHGrNb 40 FES & FHGr 41Nb), Smoke Indicator (FHGr 40 Deut FES), Incendiary (FHGrBr), Star (LtGesch) and Propaganda (Weiss Rot Geschoss)	5a, pp 71-2, 9, pp 457, 460-1, 464-5 & 470-6, and Ref 12
105 mm Naval Guns: 105 cm SK C/28, C/32 & C/33	Used HE and Star shells	5b, table 3
105 mm Medium Heavy Turret Gun: 10.5 cm sKT	Used ammo: HE (10.5 cm Gr 19 Kz 13) and AP (Pzgr Rot)	9, pp 468 & 481
105 mm AA Guns 38 and 39: 10.5 cm Flak 38 & Flak 39	Used ammo: HE (10.5 cm Sprgr L/4.4 & Sprgr L/4.4 & Sprgr L/4.4 Kz) and APC (Pzgr Rot)	9, pp 467-8 & 480 & Ref 12
105 mm Mountain Howitzer 40: 10.5 cm GebH 40	Used ammo: HE (10.5 cm FHGr Al, FHG 38 Al) HoC (Gr 39 Rot Hl/A, Hl/B & Hl/C) and Star Shell (LtGs)	5a, p 56 and Ref 12
105 mm Long Turret Gun: 10.5 cm lgKT	Used HE ammo: 10.5 cm Gr 19 Kz 13	9, p 481
105 mm Light Guns (Recoilless Airborne Guns): 10.5 cm LG (Leichtes Geschütz) 40, 40/41 & 40/42	Used ammo: HE (10.5 cm FHGr 41), HoC (Gr 39 Hl, Gr 39 HL/A Gr 39 Hl/B & Gr 39 Hl/C), Smoke (FHGr 41Nb) and Inc (FHGr Br)	5a, p 74, 9, pp 471-6 and Ref 12
105 mm Assault Howitzers: 10.5 cm StuH 40 & StuH 42	Used same ammo as 105 mm Light Field Howitzers: 10.5 cm lFH 18 etc	5a, pp 71-3, 9, pp 471-2 and Ref 12
105 mm Smoke Shell Mortar 40: 10.5 cm NbW 40	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
105 mm Compressed Air Mortar	Same as above	12
105 mm Light Gun 41 (Recoilless Airborne Gun): 10.5 cm LG 41	No description given	5a, p 74
105 mm Light Guns (Recoilless Airborne Guns): 10.5 cm LG 42 & 42/1	Used ammo: HE (10.5 cm FHGr, FHGr 38 & FHGr 38 Stg), HoC (Gr 39 Rot Hl, Gr 39 Rot Hl/A, Gr 39 Rot Hl/B & Gr 39 Rot Hl/C), Smoke (FHGr Nb & FHGr 38 Nb) and Inc (FHGr Br & FHGr 41 Br)	5a, p 75

Note: According to Ref 5b, table 7, the recoilless gun, designated as 10.5 cm LG 42, used same HE projectiles as the 10.5 cm lFH 18

Caliber and Designation	Remarks, Uses and Some Characteristics	References
105 mm Light Field Howitzer: 10.5 cm lFH 43	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
105 mm Skoda Howitzer (German designation is not given)	Used HE ammo, Models 23 and 28	9, pp 478-80
105 mm Belgian Gun: 10.5 cm K 333(b)	Used Belgian and French ammo	5a, p 81
105 mm Czech Heavy Gun: s10.5 cm K 35 (t), L 13S	Used Czech HE ammo: 10.5 cm AZGr 35 and also some French and Yugoslav ammo	5a, p 83 and 9, p 459 & 464-7
105 mm Dutch Gun: 10,5 cm K 334(h)	No description given	5a, p 85
105 mm Dutch Gun: 10,5 cm K 335(h)	Used Dutch HE ammo: 10.5 cm KGr 335 (h)	

WEAPONS

(CALIBERS 105 mm TO 128 mm)

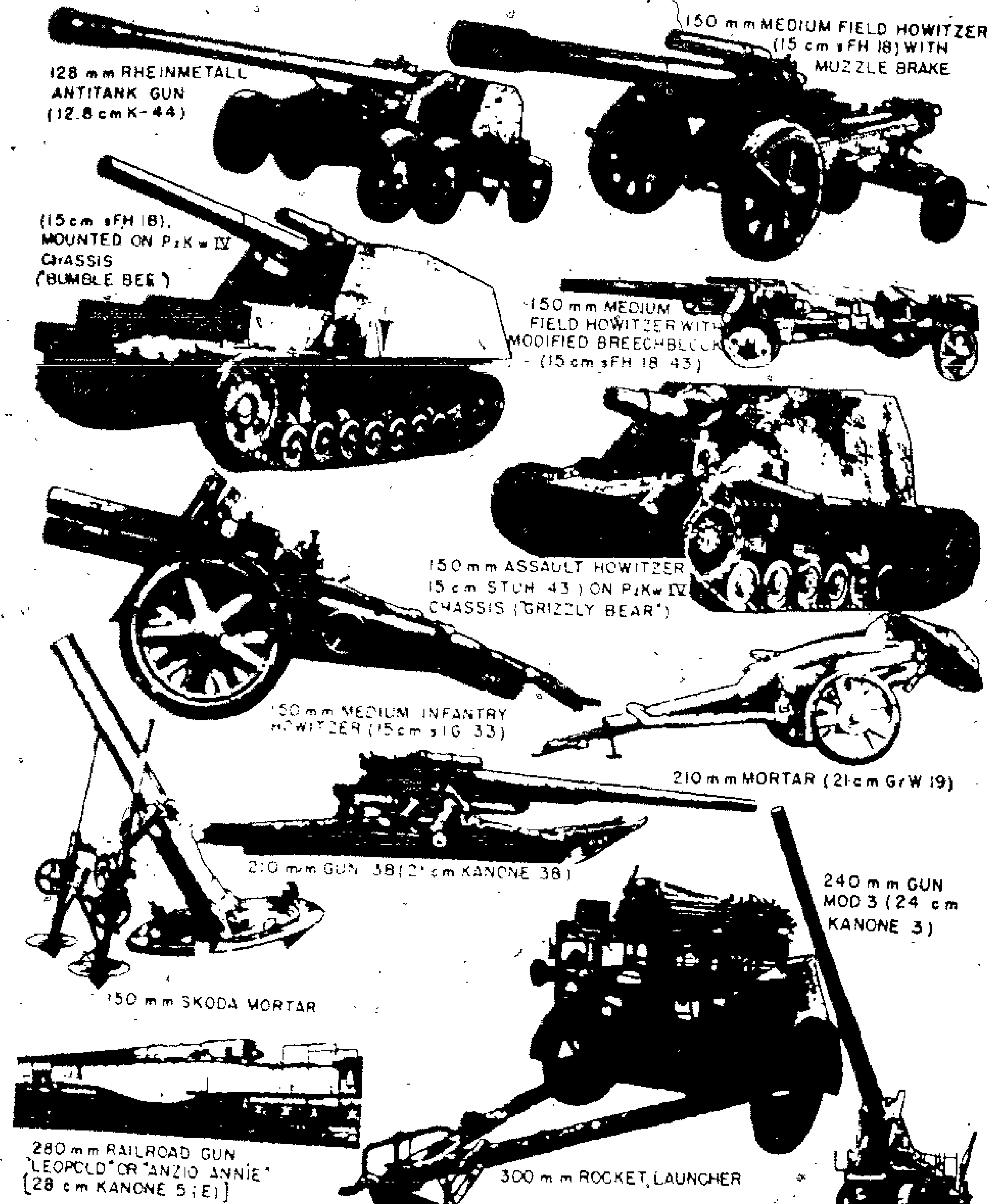


(Weapons) (cont'd)

Calibur and Designation	Remarks, Uses and Some Characteristics	References
105 mm French Guns and Howitzers: 10.5 cm FH 322 (f), 323 (f), 324 (f), 325 (f), 331 (f) and 332 (f)	Used various French ammo	5a, pp 57, 76, 81-4 & 9, pp 459, 461, 463-7
105 mm Italian Gun: 10.5 cm K 338 (i), 105/28	Used Italian HE ammo: 10.5 cm Sprgr 338/11 (i)	5a, p 83 and 9, p 462
105 mm Norwegian Field Gun: 10.5 cm FK L/28.8 Gock (n)	Used Norwegian ammo: HE (Gr M/15, M/23, M/36 & GrKartä M/04, M/15 & M/23)	5a, p 78
105 mm Norwegian Gun: 10.5 cm K 427(n)	No description given	5a, p 85
105 mm Polish Gun: 10.5 cm K 29 (p)	Used Polish and French ammo	5a, p 82 and 9, pp 459 & 464-7
105 mm Russian Guns: 10.5 cm K 348(r), K 349 (r) & K 350 (r)	No description given	5a, p 86
105 mm Yugoslav Guns and Howitzers: 10.5 cm lFH 316 (j), lFH 317 (j), lFH 317/1 (j), lFH 317/2 (j), K 321 (j), K 336 (j) & K 338 (j) (Schneider) and lGebH 329 (j)	Used Yugoslav, French and Czech ammo	5a, pp 57, 77-8, 81, 83-5 and 9, pp 459 & 464/7
107 mm (4.21") Russian Gun: 10.5 cm K 352 (r)	Used Russian ammo	5a, pp 86
114.3 mm (4.5") Gun: 11.4 cm K 365 (e)	Used British ammo: HE (11.4 cm Gr 365) and Smoke (Nbgr)	5a, p 87
120 mm (4.72") Mortar: 12 cm GrW 42	Used mortar ammo: HE (12 cm Wgr 42) and Indicating bomb (Wgr Deut)	5a, p 30 and Ref 12
120 mm Belgian Gun: 12 cm K 370(b)	Used Belgian HE ammo: 12 cm Gr (b)	5a, p 88
120 mm Norwegian Field Howitzers: 12 cm FH 375 (n) & FH 376 (n)	No description given	5a, p 91
120 mm Russian Mortar: 12 cm GrW 378 (r)	Used Russian HE mortar bomb: 12 cm Wgr 378/2 (r)	5a, p 30
120 mm Yugoslav Field Howitzer: 12 cm lFH 377 (j)	No description given	5a p 91
122 mm (5.04") Russian Guns and Howitzers: 12.2 cm FH 385 (r), FH 386 (r), FH 387 (r), lFH 388 (r), K 390, 390/1 & 390/2 (r) and sFH 396 (r)	Used various Russian 122 mm ammo: Sprgr 372, 374-377, 380, 381, 384(r), Sprgr FEW(r), GR 371 Be(r), Nbgr 385(r), Schr 383(r) and Schr 383/1(r)	5a, pp 88-90 & 9, pp 481-2
128 mm (5.90") Self-Propelled Gun 40: 12.8 cm K 40 (Pz Sfl)	Used ammo: HE (12.8 cm Sprgr L/4.5) and AP (Pzgr & Pzgr 43)	5a, pp 91-2
128 mm AA Gun 40: 12.8 cm Flak 40	Used AP ammo: 12 cm Pzgr FES & Pzgr KPS	9, p 483 & Ref 12
128 mm AA Gun 40M: 12.8 cm Flak 40M	Used AP projectiles	5b, table 8
128 mm Self-Propelled A/T Guns 44: 12.8 cm Pak 44, Krupp and Rheinmetall models	Used AP ammo: 12.8 cm Pzgr & Pzgr 43	5a, p 25; 9, p 485 and Ref 12
128 mm Light Infantry A/T Gun: 12.8 cm PJK 44 (Panzerjägerkanone) also called Tank Destroyer Gun	Used HE and AP projectiles Can be seen at the Museum of Aberdeen Proving Ground, Md	5b, table 8 and Ref 12
128 mm A/T Gun: 12.8 cm K 81/2 Experimental	Same as above	12
145 mm (5.709") French Gun: 14.5 cm K 405 (f)	Used French ammo: HE (Gr 403) and HE, cast steel (Stggr 401 & 403)	5a, p 92
149.1 mm (5.87") Naval Guns: 15 cm SK C/25, C/28, L/40, L/45 & L/55	Used HE and Star projectiles	5b, table 8
149.1 mm Torpedoboat Gun: 15 cm TbtsK C/36	Used HE and Star projectiles	5b, table 9
149.1 mm U-Boat Gun: 15 cm UtsK L/45	Used HE and Star projectiles	5b, table 8
150 mm (5.91") Long Howitzers 13: 15 cm sFH 13, sFH 13 (Sf) and sFH 13/02	Used ammo: HE (15 cm Gr 18, 19 and Dutch Gr 406), HE cast steel (Stggr 19), HE-A/C (Gr 19 Be), HE Sabot type, HoC (Gr 39 Hl & Hl/B) and Smoke (Gr 19Nb)	5a, pp 92-3 and 9, pp 371, 495 & 500
150 mm Gun 16: 15 cm K 16	Used HE howitzer ammo: 15 cm Hbgr 16 & Hbgr 16 umg	5a, p 96; 9, p 502 and Ref 12

WEAPONS

(CALIBERS 128 mm TO 300 mm)



(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
150 mm Gun 18: 15 cm K 18	Used ammo: HE (15 cm KGr 18 & 42), HE-A/C (Gr 19 Rot Be), and AP (PzSprgr L/3.7 mHbe)	5a, p 97 and 9, pp 486-7, 491 & 493
150 mm Heavy Field Howitzers: 15 cm sFH 18, sFH 18/1, sFH 18/2 and sFH 36	Used ammo: HE (15 cm KGr 18, Gr 19, & Gr 36 FES), HE cast steel (Stggr 19), HE-A/C (Gr 19Be), Rocket Assisted (RGr 19), HoC (Gr 39 HI), HE, Sabot (Sprgr 42 TS), AP, Sabot (Pzgr 39 TS) and Smoke (Gr 18Nb, Gr 19Nb, Gr 39Nb & Gr 40Nb)	5a, pp 93-4; 9, pp 492-5, 497-8, 506-7 & 509 and Ref 12
150 mm Field Howitzer: 15 cm FH 18/40	No description given	5a, p 95
150 mm Heavy Infantry Gun (Howitzer): 15 cm sIG 33 or sJG 33	Used ammo: HE (15 cm Gr 19 & Jgr 38), Rodded bomb (Stielgr 42) and Smoke (Jgr 38Nb)	9, pp 486, 494-5, 497-8, & 502 and Ref 12
150 mm Gun 39: 15 cm K 39	Used ammo: HE (15 cm KGr 18, Sprgr L/4.6 & KGr 42), A/C (Gr 19 RotBe), AP (Pzgr) and SAP (Halb Pzgr)	5a, p 98 and 9, pp 487, 493, 498 & 504-5
150 mm Railway Gun: 15 cm K (E)	Used ammo: HE (15 cm KGr 18) and AC (Gr 19 Be)	9, pp 493 & 498
150 mm Heavy Turret Howitzer: 15 cm sHT	Used ammo: HE (15 cm Gr 19 & Gr 19 Stg) and A/C (Gr 19 Be)	5a, pp 95-6 and 9, pp 495, 500 & 507
150 mm Heavy Field Howitzer: 15 cm sFH 42	Used same ammo as 15 cm sFH 18	5a, p 95
150 mm Gun on Howitzer Carriage: 15 cmKiMrsLaf	Used ammo: HE (15 cm KGr 18, Sprgr L/4.5, Sprgr L/4.6 & Sprgr mHbe), A/C (Gr 19 Rot Be) and APC BC HE (PzSprgr L/3.8 mHbe)	5a, pp 96-7
150 mm Heavy Field Howitzer: 15 cm sFH 18/43)(with modified breech-lock)	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
150 mm Assault Howitzer: 15 cm StuH 43 (L/12)	Used ammo: HE (15 cm Jgr 38 FES) and HoC (Jgr 39 HI/A)	5a, p 99; 9, pp 486 & 491 & Ref 12
150 mm Recoilless Gun: 15 cm LG 43	No information given	5a, p 93
150 mm Czech Guns and Howitzers: 15 cm K 15/16 (t), sFH 14/16(t), sFH 25(t) and sFH 37(t)	Used Czech ammo	5a, pp 99-101 & 9, pp 485 & 488-90
150 mm Rocket Launcher	Used 15 cm HE, smoke and chemical rockets	9, pp 245-7
152 mm (5.98") Rocket Launcher	Used HE rocket projectile	9, pp 247-8
152 mm Italian Heavy Field Howitzer: 15.2 cm sFH 412 (i)	Used Italian HE ammo: 15.2 cm Sprgr 412/11(i)	5a, p 106
152 mm Russian Guns and Howitzers: 15.2 cm sFH 404 (r), sFH 443(r), sFH 445(r), KH 433/1(r), KH 433/2(r) and KK 456(r)	Used Russian design HE, Smoke and Shrapnel ammo	5a, pp 104-7 & 9, pp 510-12
155 mm (6.10") Belgian Gun: 15.5 cm K 432 (b)	Used Belgian HE ammo: 15.5 cm Gr 420 & 426(b)	5a, p 108
155 mm French Guns and Howitzers: 15.5 cm sFH 414(f), sFH 415(f), K 416, 417, 418, 419, 420 & 425(f)	Used French ammo: HE and HoC	5a, pp 101-5 & 108
155 mm Polish Heavy Field Howitzer: 15.5 cm sFH 17 (p)	Used Polish HE ammo: 15.5 cm Gr 14 & 15 (p)	5a, p 101
155 mm Yugoslav Guns and Howitzers: 15.5 cm sFH 427/1 &427/2 (j) and K 403 (j)	Used Yugoslav HE ammo	5a, pp 107-8
170 mm (6.69") Gun in Mortar Mounting: 17 cm KiMrsLaf	Used ammo: HE (17 cm KGr 38 & 39), Incendiary (BrGr 39), AP (Pzgr 43) and Star Shell (Leuchtgeschoss)	5a, p 112 and 9, pp 516-17
170 mm Gun 18: 17 cm K 18	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
170 mm Railway Gun: 17 cm K(E)	Used HE ammo: 17 cm Sprgr L/4.7	5a, p 112
170 mm Austrian Gun: 17 cm K(ö)	Same as above	5a, p 112
172.6 mm (6.795") Naval Gun: 17 cm SK L/40	Used HE, AP and Star projectiles	5b, table f1
194 mm (7.64") French Railway Gun: 19.4 cm K 486(E)(f)	Used French HE, cast steel proj: 19.4 cm Stggr 486 (f) and 487 (f)	5a, p 113 and 9, p 517

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
200 mm (7.874") Light Spigot Mortar: 20 cm lLdgW (20 cm leichter Ladungswerfer)	Used HE and Smoke mortar bombs: 20 cm Wgr 40 and Wgr 40Nb	5a, p 34 and 9, p 534
200 mm Rocket Launcher	Used 20 cm AA Rocket	9, p 248
203 mm (8.0") Railway Gun: 20.3 cm K(E)	Used ammo: HE (20.3 cm Sprgr L/4.7), AP (Pzgr L/4.7) and flare (LeuchtGr)	5a, p 114 and 9, pp 520-2
203 mm Russian Heavy Howitzers: 20.3 cm H 503 (r) & H 503/2 (r)	Used Russian A/C proj: 20.3 cm Gr 503/2 Be (r)	9, p 518
203 mm Naval Gun: 20.3 cm SK C/34a	Used HE, AP and Star projectiles	5b, table 11
209.3 mm (8.24") Naval Gun: 21 cm SK L/45	Used HE and AP projectiles	5b, table 11
210 mm (8.27") Guns: 21 cm K 12 and K 12 (E)	Used HE projectile: 21 cm Gr 35	5a, p 116
210 mm Mortar 18: 21 cm Mrs 18 (Heavy Howitzer)	Used A/C proj: 21 cm Gr 18 Be	5a, p 109; 9, p 522 & Ref 12
210 mm Long Mortar 18: 21 cm lgMrs 18	Used ammo: HE (21 cm Gr 17, 17umg 18, 18 Stg) and HE-A/C (Gr 18 Be)	5a, p 109 ; and 9, p 523
210 mm Mortar 19: 21 cm Mrs 19	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
210 mm Gun 38: 21 cm K 38	Used HE shell: 21 cm KGr 38	5a, pp 114-15 and Ref 12
210 mm Guns 39, 39/40 & 39/41: 21 cm K 39, K 39/40 & K 39/41	Used ammo: HE (21 cm Gr 39 & 40), HE-A/C (Gr 39 Be) and SAP (HalbPzgr 39)	5a, pp 110-11
210 mm Gun 42: 21 cm K 42	No description given	5a, p 115
210 mm Krupp Gun: 21 cm K(Krupp)	No description given	5a, p 116
210 mm Rocket Launchers: 21 cm RAg M 42 and others	Used for launching various rockets, such as 21 cm RLg, Wgr 42 Spr and R 1000 BS	9, pp 248-9, 255-6 & 258-60
210 mm Czech Heavy Howitzer: 21 cm Mrs Kz(t)	Used Czech ammo: HE (21 cm AZGr 35) and HE High Capacity (MinGr 35)	5a, p 117
211 mm (8.27") Gun, designated K 12 (120 km range)	Used HE projectiles	5b, table 12
220 mm (8.66") French Gun: 22 cm K 532 (f)	Used French HE ammo: 22 cm Gr 534 (f) & 535 (f)	5a, p 117
220 mm Norwegian Heavy Howitzer: 22 cm Mrs M 32 (n)	No description given	5a, p 118
220 mm Polish Howitzer: 22 cm Mrs (p)	Used Polish ammo: HE (22 cm Gr 40) and SAP (HalbPzgr)	5a, p 119
220 mm Yugoslav Howitzer: 22 cm Mrs (j)	Used Yugoslav HE ammo: 22 cm Gr (j)	
234 mm (9.213") Belgian Howitzers: 234 cm H 545 (b), 545/1 (b) & 545/2 (b)	No description given	5a, pp 119-20
238 mm (9.37") Naval Gun: 24 cm SK L/40	Used HE and AP projectiles	5b, table 12
238 mm Theodore Gun: 24 cm Theodor K (E)	Used HE and AP projectiles	5b, table 12
240 mm (9.449") Howitzer 39: 24 cm H 39	Used ammo: HE (24 cm Gr 39 & 39 umg), SAP (Gr 39 Be or HalbPzgr) and French cast steel HE shell: Stggr 558/2 (f)	5a, p 120
240 mm Guns, Models 3 and 18: 24 cm K 3 & K 18	Used HE shell: 24 cm Gr 35 Mod 3 gun; can be seen at the Museum of Aberdeen Proving Ground, Md	5a, p 120 and Ref 12
240 mm Theodor Bruno Gun (Railway): 24 cm ThBrK (E)	Used HE ammo: 24 cm Sprgr L/4.2 and L/4.5	5a, p 121 and 9, pp 524-5
240 mm Naval and Seacoast Gun: 24 cm SK L/50	Used HE ammo: 24 cm Sprgr L/4.1 and L/4.2	5a, p 121
240 mm Theodor Gun (Railway): 24 cm ThK (E)	Same as above	5a, p 121
240 mm Krupp Gun: 24 cm K L/46 (Krupp)	No description given	5a, p 122
240 mm Czech Gun: 24 cm K (t)	Used Czech HE ammo: 24 cm Gr 25 (t) and Gr 40 (t)	5a, p 122 and 9, p 525

(Weapons) (cont'd)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
240 mm French Guns: 24 cm K(E) 557 (f) & K 558 (f)	Used French HE cast steel shell: 24 cm Stggr 557 (f)	5a, p 123
240 mm French Guns: 24 cm K 546 (f) & K 566 (f)	No description given	5a, pp 122-3
240 mm Russian Howitzer: 24 cm H 564 (r)	No description given	5a, p 122
270 mm (10.6") French Coast Howitzer: 27 cm Küste Mrs 585 (f)	No information available	5a, p 124
274 mm (10.76") French Railway Guns: 27.4 cm K (E) 591 (f) and K(E) 592 (f)	Used French HE ammo: 27.4 cm Gr 593, 594, 595 and 596 (f)	5a, p 124
280 mm (11.024") Howitzer: 28 cm H L/12	Used HE shell: 28 cm Sprgr L/3.5	5a, p 124
280 mm Coast Howitzer: 28 cm Küste H	Same as above	5a, p 125
280 mm Short Bruno Gun (Railway) 28 cm KzBrK (E)	Used ammo: HE (28 cm Sprgr L/4.1) and HEAP (PzSprgr L/2.6)	5a, p 125
280 mm Long Bruno Gun (Railway): 28 cm LgBrK (E)	Used HE ammo: 28 cm Sprgr L/4.4	5a, pp 125-6
Note: According to Ref 5b, table 13, the short and the long Bruno guns were 283 mm		
280 mm Theodor Bruno Gun (Railway): 28 cm ThBrK (E) or BrNK	Used HE ammo: 28 cm Gr 39 mHbgrZ	5a, p 126 and 9, p 529
280 mm Gun, Model 5 (Railway): 28 cm K 5(E), nicknamed "Leopold" and "Anzio Annie"	Used ammo: HE (28 cm Gr 35 & Gr 42) and rocket-assisted (RGr L/4.7)	5a, p 126; 9, pp 527-8 and Ref 12
280 mm Guns (Railway): 28 cm K 5/1 (E) and K 5/2 (E)	Used HE ammo: 28 cm Gr 39/42 & Gr 42	5a, p 127
280 mm Naval and Seacoast Gun: 28 cm SK L/50	Used ammo: HE (28 cm Sprgr L/3.6) and AP (Pzgr L/3.2)	5a, p 127
280 mm French Heavy Howitzers: 28 cm Mrs 601 (f) and 602 (f)	No description given	5a, p 128
280 mm Russian Howitzers: 28 cm H 34/35 (r) and H 607 (r)	No description given	5a, p 127
280 Rocket Launcher	Used HE rocket proj: 28 cm WkSpr	9, pp 249-51
283 mm (11.142") Naval Guns: 28 cm SK C/28, C/34 & C/40	Used HE and AP projectile	5b, tables 12 and 13
300 mm (11.81") Self-Propelled Trench Mortar	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
300 mm Rocket Launcher, New Type	Used HE rocket proj: 30 cm Wk 42 Spr	9, pp 251-3 and Ref 12
305 mm (12.00") Naval and Seacoast Gun: 30.5 cm SK L/50	Used ammo: HE (30.5 cm Sprgr L/3.6) and AP (Pzgr L/3.4)	5a, p 129
305 mm Czech Howitzer: 30.5 cm Mrs (t)	Used Czech ammo: HE (30.5 cm Gr 35) and HE-High Capacity (MinGr 35)	5a, p 128
305 mm Belgian Howitzer: [30.5 cm H 632(b)], Russian Howitzers [H 622 & 625 (r)] and Yugoslav Gun [M 638 (j)]	No description given	5a, pp 129-30
310 mm (12.397") Glatt Gun on Railway Mount	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
320 mm Rocket Launcher (No German designation is given)	Used HE rocket ammo designated as 32 cm Wk	9, pp 253-4
340 mm (13.389") French Gun: 34 cm K 673 (f)	Used French ammo: HE, cast steel (34 cm Stggr) and AP (Pzgr)	5a, p 130
355 mm (13.975") Howitzer M-1: 35.5 cm M1, known also as M1 Gun	Used A/C ammo: 35.3 cm GrBe, Rö(Röchling) Gr 42 Be and RöGr 44 Be	5a, p 130; 9, p 529 & Ref 12
Note: According to Ref 5b, table 14, the M1 gun was 350 mm		
365 mm (14.37") Recoilless Gun: 36.5 cm G 104, developed during WW II by the Rheinmetall-Borsig A-G	Not described here because Ref 8, v 3 is confidential	8, v 3, pp 614 & 623
370 mm (14.567") French Gun: 37 cm K 710 (f)	No description given	5a, p 131

(Weapons) (con't)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
380 mm (14.96")-Heavy Spigot Mortar (38 cm SLdgaW) (38 cm schwerer Ladungswerfer)	Used HE and Smoke mortar bombs: 38 cm Wgr 40 and Wgr 40Nb	5a, p 34 and 9, p 535
380 mm Siegfried Railroad Gun: 38 cm SiK (E)	Used ammo: HE (38 cm Sprgr L/4.5 & L/4.6) and AP (Pzgr L/4.4)	5a, p 131

Note: According to Ref 5b, table 14, the Siegfried gun was used as a coast defence gun

Caliber and Designation	Remarks, Uses and Some Characteristics	References
380 mm Naval Gun: 38 cm SK C/34	No description given	5b, table 14
380 mm Rocket Launcher (No German designation is given)	Used HE rocket, designated 38 cm RSprgr 4581	9, pp 254-5
380 mm Rocket Projector (Sturmmörser) mounted on tank: PzKpfWg IV	Can be seen at the Museum of Aberdeen Proving Ground, Md	12
406 mm (16") Adolf Gun: 40.6 cm SK C/34	Used ammo: HE (40.6 cm Gr 40, Adolf Gr L/4.2, Sprgr L/4.6 & L/4.8) and HEAP (PzSprgr L/4.4)	5a, pp 131-2
420 mm (16.54") Howitzer called by the Germans Gamma Mörser	Used heavy A/C shell: 42 cm sGrBe	5a, p 132

Note: According to W.Ley, Coast Arty J, Jan-Feb 1943, p 16, the word Mörser referred to short medium and heavy howitzers with barrels from 12 to 16 calibers long, while the word Haubitze was restricted to field howitzers. The Austrian usage was not quite uniform, some heavy howitzers were called Mörser, while others were called Haubitzen

Caliber and Designation	Remarks, Uses and Some Characteristics	References
420 mm Czech and Russian Howitzers: 42 cm Mrs (t) and 42 cm H (r)	Same as above	5a, p 132

Note: According to W.Ley, Coast Artillery Journal, Jan - Feb 1943, pp 14-15, the following heavy ordnance was developed prior or during WW I: 17 cm L/40 gun, 21 cm L/40 & L/45, 21 cm L/150 (Parisgeschütz or Ferngeschütz), 21 cm L/12 howitzer, 23.5 cm L/132 cm L/132 gun (Parisgeschütz or Ferngeschütz), 24 cm L/30 & L/40 guns, 24.4 cm howitzer (presumably called Alpha), 28 cm L/40 & L/45 guns, 28cm L/12 & L/14 howitzers (Schwere Küstenhaubitze), 30.5 cm L/50 gun, 30.5 cm L/8 howitzer (called Beta or Schwerer Küstenmörser), 30.5 cm L/12 howitzer (Schwerer Küstenmörser), 30.5 cm L/16 howitzer (called Beta 09 L/16), 30.5 cm L/17 howitzer (nicknamed Kartaune in honor of the German 15th century gun), 35.6 cm L/52.5 gun (built by the Krupp Co for the Greek battleship Basileos Gheorgios but requisitioned by the Germans before it was delivered), 38.1 cm L/45 coast defense gun (nicknamed Der lange Emil), 42 cm L/14 howitzer (called M or KMK L/14 Kurze Marine Kanone, Lange 14) and nicknamed Dicke Bertha (fat Bertha, not referring to Frau Bertha von Krupp), Dickes Luder (fat wench), Tante aus Essen (aunt from Essen), etc and 42 cm L/16 howitzer [called KMK, Gamma or Eisenbahn 42 (railroad 42)]. It has to be mentioned that the shells for the Dicke Bertha were usually called Eiserne Portion (iron portion), while the shells for heavy, flat trajectory, Naval guns were nicknamed Kohlenkasten (coal box)

According to the above author, the long 21 cm and 23.5 cm guns used for shelling Paris were called erroneously Big Berthas. The official name of each of these guns was Kaiser Wilhelm Geschütz but was usually referred to as Parisgeschütz or Ferngeschütz. The crews of the guns made no distinction between the two types and called them Die Pariserin (La Parisienne)

The term Big Bertha should be reserved for the 42 cm L/14 howitzer, nicknamed by the Germans the Dicke Bertha

Caliber and Designation	Remarks, Uses and Some Characteristics	References
533.4 mm (21.14") Gun, designated as Gerät 36	No description given	5b, table 14
540 mm (21.26") Heavy Howitzer: 54 cm Karl Mörser or Karl Gerät, called also self-Propelled Mortar M 41	Can be seen at the Museum of Aberdeen Proving Ground, Md (See also under Panzer)	5a, p 133 and Ref 12

Note: According to G.B.Jarrett, "Achtung Panzer," Great Oaks, RD1, Aberdeen, Maryland (1948), p 98 there were 540 mm and 610 mm weapons called Thor and Karl Mortars (See under T). According to W.Ley, Coast Arty J, Jan-Feb 1943, p 20 the Thor was likely to be 610 mm but some observers claimed only 510 mm

Caliber and Designation	Remarks, Uses and Some Characteristics	References
615 mm (24.21") Heavy Howitzer: 61.5 cm Karl Mörser	Used HE shell called: Geschoss L/41 für Karl Gerät	5a, p 133

Note: According to W.Ley, Coast Artillery Journal; Jan-Feb 1943, p 13, the Germans used at the siege of Sevastopol the following super-heavy weapons: 610 mm (appr 24") rifled mortar (short howitzer), 690 mm (appr 27") short Naval rifled gun, railroad mounted and 715 mm (appr 28") rifled mortar (short howitzer)

Caliber and Designation	Remarks, Uses and Some Characteristics	References
800 mm (31.5") Super Heavy Gun: 80 cm Gustav Geschütz, known also as Sevastopol Gun. (See also "Sevastopol Gun" in descriptive section)	Used HE shell: 80 cm Gustav Granate, which can be seen at the Museum of Aberdeen Proving Ground, Md	5a, p 133; Ref 12 & F.B.Porter, Field Arty J 35, 545 (1945)

Note: L.E.Simon stated in his book "German Research in World War II", J.Wiley, N Y (1947), p 187 that: "Krupp undertook the development of a 1500-ton tank to mount the 90 cm Krupp gun which was used at Sevastopol. It was designed for operation in built-up areas. This development was stopped before the war ended". According to other sources of information the Sevastopol Gun was 80 cm. One of the photographs in the files of Aberdeen Proving Ground gives the caliber of Gustav Geschütz as 82 cm

References: See p 226

Abbreviations:

American and British: AA Antiaircraft; AC Aircraft; A/C Anticoncrete; AP Armor-piercing; A/P Antipersonnel; A/T Antitank; BC Ballistic cap (windshield); C Capped; CAP Colt automatic pistol (ammunition); ft/sec feet per second; HE High explosive; HeC Hollow charge; How Howitzer; I or Inc Incendiary; lb pound(s); M Model; max maximum; MG Machine gun; MP Machine Pistol; muz vel muzzle velocity; oz ounce(s); PG Proving Ground; Ref Reference; rpm rounds per minute; SAP Semi-armor-piercing; sec second(s); T Tracer; v volume (of a book); Wt Weight

German: See Abbreviations at the end of German vocabulary.

Table 64 Wettersprengstoffe

(For definition of Wettersprengstoffe see p 226)

Designation	Composition %														Remarks	References
	Am nitrate	Ba nitrate	MNN	NG	Wood Meal	DNT	TNT	K nitrate	Naphthalene	Carbon	K chloride	Na chloride	50% soln of Ca nitrate	Other Ingredients		
W-Agesid A	27.0	-	-	30.0 (Gel)	-	-	-	-	-	-	38.0	-	-	Na nitrate 3.4, Mg silicate 1.6	Gel	2&4
W-Albit	Mentioned in Ref 1, p 428 but no composition was given.															
W-Ammoncahücit A	64.7	-	-	4.0 (Gel)	1.3	-	8.0	-	-	2.0	-	20.0	-	-	Non-gel	2&4
W-Ammoncahücit B	67.0	-	-	4.0 (Gel)	1.5	6.0	-	-	-	1.5	-	20.0	-	-	Non-gel	2&4
W-Ammoncahüsit D} W-Ammoncahüsit E}	Marshall, v 3, p 121 lists them as having compositions similar to W-Ammoncahüsites A and B and W-Detonite															
W-Arit A	29.5	-	-	25.8 (Gel)	-	-	3.7	-	-	-	-	40.0	-	Glycerin 1.0	Gel	2&4
W-Arit B	31.0	-	-	25.8 (Gel)	-	-	4.2	-	-	-	-	38.0	-	Glycerin 1.0	Gel	2&4
W-Astralit A	57.0	-	-	12.0 (Gel)	2.0	-	2.0	-	-	-	-	27.0	-	-	Semi-gel	2&4
W-Astralit of pre-WW I	74.5	-	-	4.0 (Gel)	1.0	-	7.0	-	-	1.0	-	10.0	-	Vaseline or paraffin 2.5	Non-gel	6
W-Baldurit A	50.0	-	-	12.0 (Gel)	2.0	2.0	-	-	-	0.5	-	33.5	-	-	Semi-gel	4
W-Barbarit A	25.0	3.0	-	30.5 (Gel)	-	0.5	-	-	-	-	40.0	-	-	Talc 1.0	Gel	4
W-Barbarit B	24.0	2.5	-	30.0 (Gel)	-	-	-	-	-	-	-	41.5	-	Talc 1.0, Glycerin 1.0	Gel	4
W-Bavarit A	55.0	-	-	12.0 (Gel)	1.0	3.0	-	-	-	1.0	-	28.0	-	-	Semi-gel	4
W-Bavarit B	56.0	-	-	12.0 (Gel)	-	2.0	2.0	-	-	-	-	28.0	-	-	Semi-gel	4
W-Carbonit A	26.5	-	-	30.0 (Gel)	0.5	-	-	-	-	-	-	40.0	3.0	-	Gel	2&4
W-Dahmenit A	81.0	8.0	-	4.0	1.0	-	2.0	-	-	-	4.0	-	-	-	Non-gel	2&4
W-Detonit A	82.0	-	1.0	4.0	2.0	-	-	-	-	0.5	10.5	-	-	-	Non-gel	2&4
W-Detonit B	81.0	8.0	-	4.0	1.0	-	2.0	-	-	-	4.0	-	-	-	Non-gel	2&4
W-Detonit C	64.5	-	-	4.0	1.5	-	7.0	-	-	-	-	23.0	-	-	Non-gel	5
W-Donarit A	82.0	-	1.0	4.0 (Gel)	2.0	-	-	-	-	0.5	10.5	-	-	-	Non-gel	2&4
W-Donarit B	81.0	8.0	-	4.0	1.0	-	2.0	-	-	-	4.0	-	-	-	Non-gel	2&4
W-Donarit A (1936)	See under Commercial Explosives of WW II															
W-Dynamit No 1	-	-	-	30.0	6.0	-	-	-	2.0	-	-	-	-	Na nitrate 31.0, Alum 1.0, Flour 30.0	Non-gel	Barnett, Explosives (1918), p194
W-Dynammon	94.0	-	-	-	-	-	-	2.0	-	4.0	-	-	-	-	Non-gel	Marshall, v1, p 392
W-Fördit A	75.0	-	-	4.0	2.0	-	-	-	-	0.75	18.25	-	-	-	Non-gel	2&4
W-Fulmenit	76.5	-	-	-	-	-	5.5	-	-	1.5	-	10.0	-	Guncotton 4.0, Paraffin oil 2.5	Non-gel	Marshall, v 1, p 391
W-Lignosit A	62.0	-	-	4.0	4.0	0.7	6.3	5.0	-	-	-	18.0	-	-	Non-gel	2&4
W-Lignosit B	61.5	3.0	-	4.0 (Gel)	4.0	5.0	-	-	-	-	-	22.5	-	-	Non-gel	2&4
W-Lignosit C	Marshall, v3, p 121 lists this explosive but does not give the composition															
W-Lignosit D	82.0	-	-	4.0	1.0	1.5	-	-	-	0.5	-	11.0	-	-	Non-gel	5
W-Merkanit A	32.0	-	-	26.0 (Gel)	1.0	2.0	-	-	-	-	-	36.5	2.5	-	Gel	2&4
W-Monakit A} W-Monakit B}	Marshall, v3, p 121 lists both W-Monachites as non-gelatinized explosives - similar to W-Ammoncahüsites, W-Detonites, W-Lignosites and W-Westfalites												-	-	-	

Table 64 (contd)

W-Nobelit A	32.0	-	-	26.0 (Gel)	1.0	2.0	-	-	-	-	-	36.5	2.5	-	Gel	2,4&6
W-Nobelit B	26.5	-	-	30.0 (Gel)	0.5	-	-	-	-	-	-	40.0	3.0	-	Gel	2,4&6
W-Nobelit C	29.3	-	-	24.7 (Gel)	1.0	2.0	-	-	-	-	-	38.0	5.0	-	Gel	2&4
W-Nobelit A(1932), W-Nobelit B(1932)	See under Commercial Explosives of WW II															
W-Perchlorit 1	32.0	-	-	-	3.0	8.0	-	-	-	-	-	23.00	-	K perchl 30.0, DNN 4.0	Non-gel	1
W-Perchlorit IV	34.0	-	-	-	3.0	10.0	-	-	-	1.0	-	22.0	-	K perchl 30.0	Non-gel	1
W-Persalit	Marshall, v1, p 384 mentions this explosive but does not give its composition															
W-Salit A	57.0	-	-	12.0 (Gel)	2.0	-	-	-	-	1.5	27.5	-	-	-	Semi-gel	5
W-Siegrit A	57.0	-	-	12.0 (Gel)	2.0	-	-	-	-	2.0	-	27.0	-	-	Semi-gel	4&6
W-Sonnit A	81.0	8.0	-	4.0	1.0	-	2.0	-	-	-	4.0	-	-	-	Non-gel	2&4
W-Wasagit A	20.0	10.0	-	28.0 (Gel)	-	-	-	-	-	-	40.5	-	-	Gelose 1.0, Talc 0.5	Gel	2&4
W-Wasagit B	36.0	-	-	26.0 (Gel)	0.3	1.35	1.35	-	-	-	35.0	-	-	-	Gel	2&4
W-Wasagit A of WW II, W-Wasagit B of WW II	See under Commercial Explosives of WW II															
W-Westfalit A	84.0	2.4	-	4.0	-	-	-	-	-	-	8.0	-	-	-	Non-gel	2&4
W-Westfalit B	82.0	-	-	4.0	1.5	-	-	-	1.6	1.5	11.0	-	-	-	Non-gel	2&4
W-Westfalit C	80.0	2.0	-	4.0	2.0	-	1.5	4.0	-	-	5.0	-	-	m-MNT 1.5	Non-gel	2&4
W-Westfalit A of WW II	See under Commercial Explosives of WW II															
W-Zellit A	35.0	-	-	15.0 (Gel)	-	-	-	-	-	-	-	23.0	-	Cellulose 12.0, Na nitrate 15.0	Semi-gel	5

Abbreviations: **Atm** Atmosphere; **DNN** Dinitronapthalene; **DNT** Dinitrotoluene; **Gel** Gelatinous explosive; **m-MNT** m-Mononitrotoluene; **MNN** Mononitronaphthalene; **NC** Nitrocellulose; **NG** Nitroglycerin; **Non-gel** Non-gelatinous explosive; **perchl** perchlorate; **Semi-gel** Semi-gelatinous explosive; **TNT** Trinitrotoluene; **W** Wetter (firedamp)

Note: Most of the explosives in Table 64 were on the "Liste der Bergbau Sprengstoffe" (List of Mining Explosives) used prior to WW II.

Table 65 Properties of Some Wetter-Sprengstoffe

Explosive	Oxygen Balance %	Density of Charge	Veloc of Deton, m/sec	Trauzl Test (Lead Block Expansion) cc	Sensitiveness to Initiation Requires at least:	Gap Test, (using 30 mm cartridges)	*Heat of Explosion, kcal/kg	Temper of Explosion, °C	Vol. of Gases in l/kg at 20°C & 760 mm	Specific Pressure (f) * atm-l/kg	Brisance (B), ** (by Kast formula)	Brisance (by Pb block crushing) mm	Reference
W-Astralit A	+4.1	1.21	3800	210	No 1 cap	25 mm	601.0	1738	-	-	-	10.0	2
W-Dahmenit A	+16.1	1.06	3650	220	No 3 cap	40 mm	462.0	1388	821.0	5300	17200	8.3	2
W-Detonit A	+10.9	1.04	3600	230	No 3 cap	40 mm	548	1520	-	-	-	8.5	2
W-Detonit A	+10.4	1.06	3000	215	-	-	516.0	1730	772.3	5853	18600	10.5	7
Note: No composition of this second W-Detonit A could be found in any of the sources at our disposal													
W-Detonit B	Same as for W-Dahmenit A												
W-Detonit C	-	1.05	3200	-	-	-	531.0	1490	763.0	4740	15900	-	5
W-Donarit A	Same as for W-Detonit A												
W-Donarit B	Same as for W-Dahmenit A												
W-Dynamit 1	-	1.16	3900	-	-	-	-	-	-	-	-	-	
W-Lignosit D	-	1.04	3000	-	-	-	-	-	-	-	-	-	Barnett p 194
W-Nobelit B	-	1.7	5650	-	-	-	518.0	1480	911.0	5620	17500	-	5
W-Salit A	-	1.1	3300	-	-	-	568	1615	538.0	3690	35400	-	5
W-Sonnit A	Same as for W-Detonit B						607.0	1830	711.0	5300	19200	-	5
W-Zellit A	-	0.6	3000	-	-	-	937.0	2630	-	6370	11500	-	5

* Specific pressure (Spezifisches Druck), (f) is calculated according to the formula given on p 51 of Ref 5.
** Brisance by Kast (Brisanzwert nach Kast), (B) is calculated according to the formula given on p 57 of Ref 5.
(See also in general section)

The explosives of Table 64 were divided into three groups:

A. **Ammonsalpeter-Wettersprengstoffe** (Ammonium Nitrate Permissible Explosives), marked in Table 64 above as Non-gel (Non-Gelatinous)

B. **Nitroglycerin-Wettersprengstoffe** (Nitroglycerin Permissible Explosives), marked in Table 64 above as Semi-gel (Semi-gelatinous)

C. **Gelatinöse-Wettersprengstoffe** (Gelatinous Permissible Explosives), marked in Table 64 above as Gel (Gelatinous).

The (A) group included powdery compositions with a NG content not higher than 5% and a density of about 1.0. Wetter Ammoncahusit, W-Astralit, W-Detonit, W-Lignosit, W-Monachit and W-Westfalit belonged to this group. They were suitable for blasting soft coal.

The (B) group included partly gelatinous but not plastic compositions containing 12-15% of NG-NC gel and had a density of about 1.3. Wetter-Baldurit A, W-Bavarit A, W-Salit A and W-Siegrit A belonged to this group. They were suitable for blasting hard coal and rock seams.

The (C) group included gelatinous (plastic) explosives which contained about 30% of NG-NC gel and had a density up to 1.7. Wetter-Arit A, W-Barbarit A, W-Carbonit, W-Nobelit and W-Wasagit belonged to this group. They were suitable for blasting hard rock.

Table 65 gives the properties of some Wetter-Sprengstoffe listed in Table 64 (See previous page).

Note: According to Marshall, v 3, p 123, all German coal mining explosives contained a large excess of oxygen. This achieved two purposes:

a) It lowered the brisance of an explosive so that the coal would not be broken into very small pieces
b) It avoided the formation of carbon monoxide which is undesirable because of its high toxicity.

Too large an excess of oxygen also had to be avoided because it caused the formation of nitrogen oxides which are poisonous (although not as much as carbon monoxide).

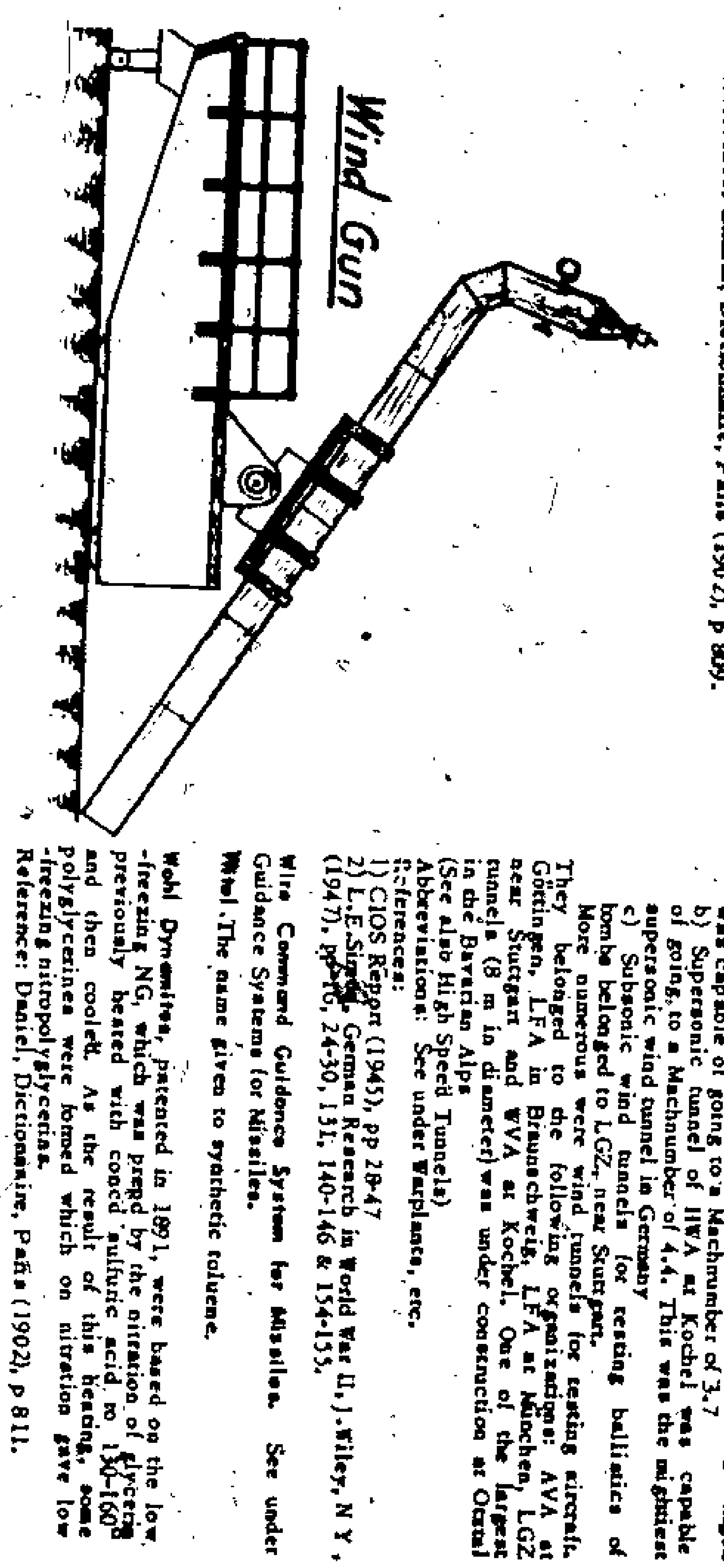
References:
1) P.Naoúm, Schiess- und Sprengstoffe, Steinkopf, Dresden (1927), p 147
2) P.Naoúm, Nitroglycerin etc, Williams & Wilkins, Baltimore (1928), pp 389, 414-16, 428, 436-39 & 444
3) A.Marshall, Explosives, Churchill, London, v 1 (1917), v 3 (1932) pp 121-3
4) J.Pepin Lehalleur, Poudres, Explosifs, et Artifices, Baillière, Paris (1935), pp 411-14
5) C.Beyling & K.Drekopf, Sprengstoffe und Zündmittel, Springer, Berlin (1936), pp 32, 100-05
6) Thorpe's Dictionary of Applied Chemistry, Longmans, Green, London, v 4 (1940), pp 554-6
7) P.Naoúm, S S 39, 54 (1944) (Table giving properties of W-Detonit A and W-Nobelit A)
8) A.Stettbacher, Spreng- und Schiesstoffe, Rascher, Zürich (1948), p 91.

(See also Schlagwettersichere Sprengstoffe and Sicherheitssprengstoffe).

Weyel Explosives, patented in 1895, were based on a mixture of NG and coal tar (creosote), as for instance: NG 27.0, creosote 4.5, collod cotton 1.0, Na nitrate 53.0, rye flour 9.0 and Na bicarbonate 5.5%.
Reference: Daniel, Dictionnaire, Paris (1902), p 808.

Wgr 21 cm. An air-to-air, solid propellent rocket developed in 1943. Launching weight 176 lb, overall length 3.7 ft, diameter 8.3" and velocity (all burnt), 1,050 ft/sec.

Wilhelm Explosives, patented in 1894, were manufactured by Dynamit A-G. E g:
a) Am nitrate 90 and aniline tartrate (neutral) 10%
b) Am oxalate 94 and naphthylamine oxalate 6%.
Reference: Daniel, Dictionnaire, Paris (1902), p 809.



Wind Gun, developed during WW II in Stuttgart, was designed to shoot a mass of air at an airplane in such a way as to bring it down. The energy for projecting the air was supplied by heat produced on burning a mixture of oxygen and hydrogen. It was claimed that the air shot from this gun could break a 1-inch board at a range of 200 meters, but at longer ranges it was not effective (See drawing below).
Reference: L.E.Simon German Research in WW II, Wiley, N Y (1947), p 180.

Wind Tunnel (Windkanal). Many wind tunnels were used in Germany during WW II. Of these the following were used for ballistic testing of weapons and ammunition:
a) Supersonic ballistic tunnel of AVA at Göttingen was capable of going to a Machnumber of 3.7
b) Supersonic tunnel of HWA at Kochel was capable of going to a Machnumber of 4.4. This was the mightiest supersonic wind tunnel in Germany
c) Subsonic wind tunnels for testing ballistics of bombs belonged to LGZ, near Stuttgart.

More numerous were wind tunnels for testing aircraft. They belonged to the following organizations: AVA at Göttingen, LFA in Braunschweig, LFA at München, LGZ near Stuttgart and WVA at Kochel. One of the largest tunnels (8 m in diameter) was under construction at Otztal in the Bavarian Alps
(See also High Speed Tunnels)
Abbreviations: See under Warplants, etc.
References:
1) CIOS Report (1945), pp 28-47
2) L.E.Simon, German Research in World War II, J.Wiley, N Y, (1947), pp 16, 24-30, 131, 140-146 & 154-155.

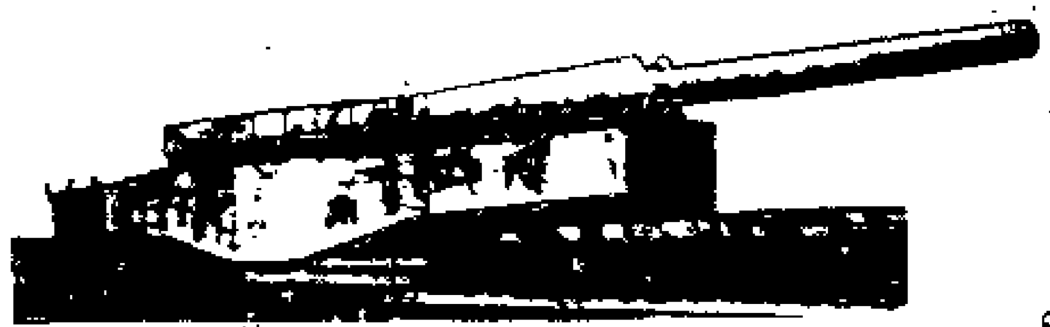
Wire Command Guidance System for Missiles. See under Guidance Systems for Missiles.

Witol. The name given to synthetic toluene.

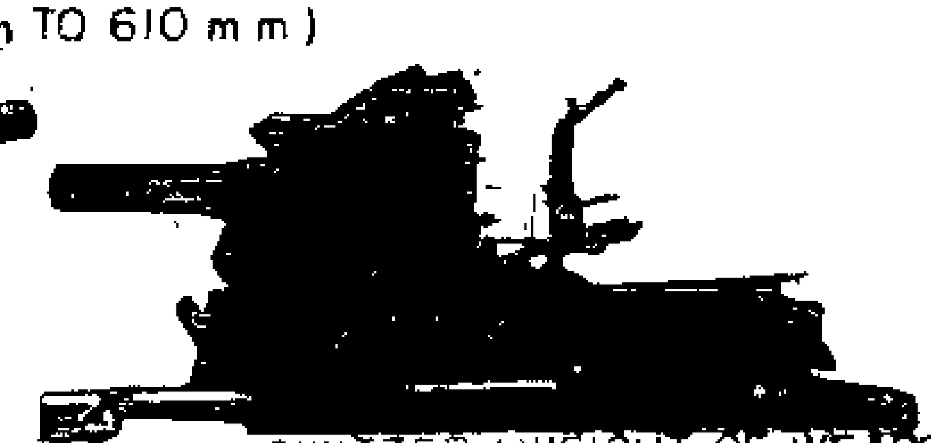
Wohl Dynamites, patented in 1891, were based on the low-freezing NG, which was prepd by the nitration of glycerin previously heated with concd sulfuric acid to 130-160° and then cooled. As the result of this heating, some polyglycerines were formed which on nitration gave low-freezing nitropolyglycerins.
Reference: Daniel, Dictionnaire, Paris (1902), p 811.

WEAPONS

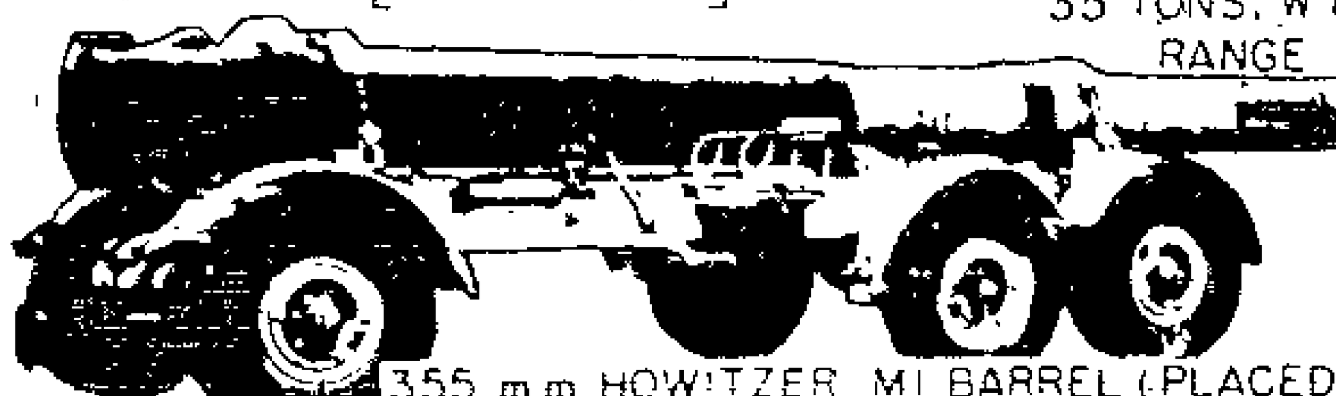
(CALIBERS 310 mm TO 610 mm)



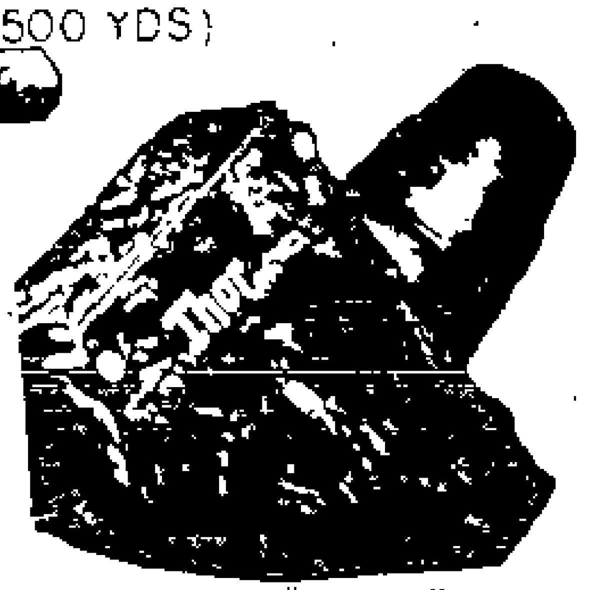
310 mm GLOTT GUN, MOUNTED ON 280 mm RAILWAY GUN [28 cm K 5 (E)] MOUNT



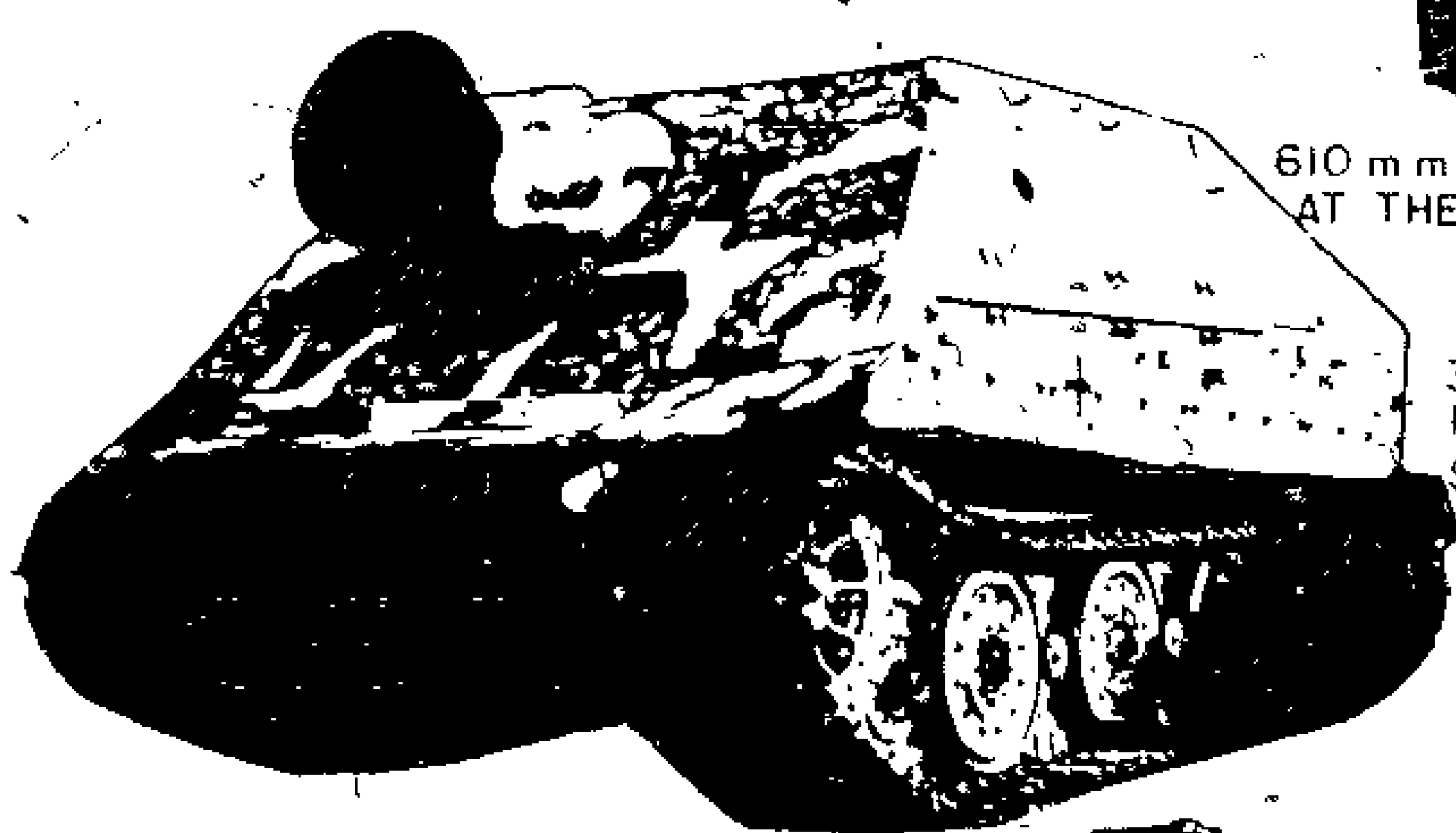
420 mm HOWITZER (WEIGHT OF WEAPON 35 TONS, WT OF PROJECTILE 1750 LB, RANGE 14500 YDS)



355 mm HOWITZER MI BARREL (PLACED ON TRANSPORT CARRIER)

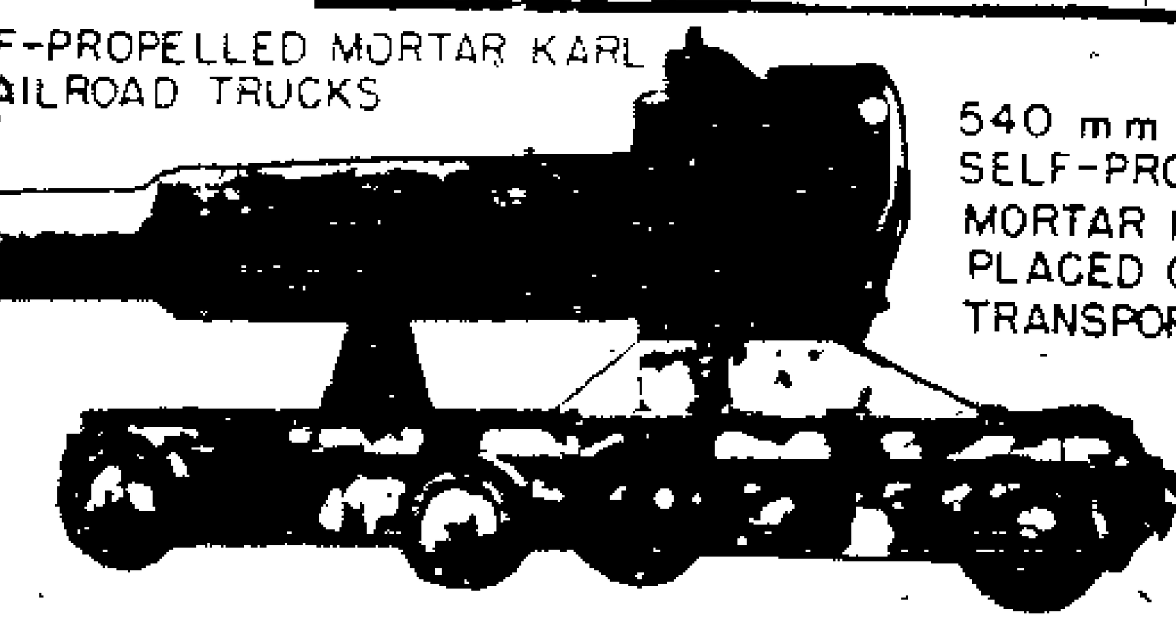


610 mm MORTAR "THOR" (USED AT THE SIEGE OF SEVASTOPOL)



380 mm ROCKET PROJECTOR (38 cm STURMMÖRSER), PLACED ON PzKw VI CHASSIS

540 mm SELF-PROPELLED MORTAR KARL GERÄT ON RAILROAD TRUCKS



540 mm BARREL OF SELF-PROPELLED MORTAR KARL GERÄT, PLACED ON TRANSPORT CARRIER

WP (**Würfelpulver**) (Cubical or Prismatic Propellant). A flaked smokeless propellant in the form of small rectangular grains. It was first manufd under the name of WPC/89 (Würfelpulver Construction 1889) by the Vereinigte Köln-Rottweiler Pulverfabrik in Rottweil, Württemberg for use in the Army guns, caliber 37 mm, 53 mm and 150 mm. The composition of WPC/89 was similar to the Italian Ballistite (Ref 1).

Barnett (Ref 2) gives the composition of an early WP as follows: NG 50, NC 50% and small quantity of DPhA, added.

Brunswig (Ref 3) gives for WP used after WW I: NG 38.5, NC 60, centralite; or acardite 1.0 and moisture 0.5%.

References

1) J.Daniel, Dictionnaire des Matières Explosives, Dunod, Paris (1902), p 811
2) E.Barnett, Explosives, Van Nostrand, N Y (1919), p 78
3) H.Brunswig, Das rauchlose Pulver, W de Gruyter, Berlin 1926), p.136.

WPC/89. See under WP (Würfelpulver)

W-Salz. The name given to Hexogen (RDX) prepd by the nitration of K methyleneamine sulfonate (See under Hexogen)

Würfelpulver. See WP.

Würgebohrung Geschütz. See Tapered Bore Gun.

X-4 was a fin-stabilized guided missile with a proximity fuzed warhead developed especially for use by fighter planes against enemy bomber formations. It was propelled by a liquid fuel (Tonka 250) and an oxygen carrier (Salbei). Some experimental models were equipped with devices called "Kranich" and "Pudel" [TM 9-1985 (1953), pp 215-19].

X-Ray Equipment (Röntgeneinrichtung). A short description of the x-ray equipment manufacturing industry is given in CIOS Report 28-31 (1945).

X-Series Guided Missiles. See Ruhrstahl under Guided Missiles.

X-Stoff. See Tetan.

Zabel, in 1899, constructed a metallic cartridge consisting of two compartments divided by a thin partition. In one of the compartments was a mixture of Ca carbide and Ba peroxide, while the other contained a dilute acid solution. On breaking the partition the acid reacted with carbide and peroxide to form a mixture of acetylene and oxygen which immediately exploded.

Reference: Daniel, Dictionnaire (1902), p 814.

Zeitschnur (Time Fuse), called in the U S A Safety or Blasting Fuse. See under Fuses in the general section.

Zeitschnurzeitzünder (Time Igniter With Fuse). See under Electric Igniters, or Primers and also in Beyling-Drekopf (1936) pp 175 & 266-69.

Zell-Igelit was a porous vinyl chloride polymer laminate for use as an outside armor for the air intake tube (Schnörkel) as well as for the periscope in order to prevent the detection of submarines by short waves sent from enemy planes by radar.

The pores of Zell-Igelit contained nitrogen generated within the material by a special process involving the use of a substance known as "Porofor N". For this a mixture consisting of polyvinyl chloride 95 and Porofor N 5% was heated in an autoclave at 130° and then the mass was laminated. During this process the Porofor N dissolved in the vinyl chloride and reacted with the liberation of nitrogen which formed bubbles inside the material. Each Schnörkel tube was covered with 7-8 layers of the above porous laminate each layer being separated from the other by interposing carbon black coated paper, which was slightly conductive to electricity. It was assumed that the incoming short waves from a radar generated convection currents within the carbon paper and these currents were subsequently buffered if not completely absorbed by the laminates. Reflection of the short wave was thus minimized if not completely absorbed by the insulating mass.

Reference: CIOS Report 25-18 (1945), pp 29-30.

Zellpech. See under Raschig's White Blasting Powder.

Zinn (Tin). See general section.

Note: According to A.Stettbacher, Spreng- und Schiesstoffe, (1948), p 43, small quantities of tin, (or of its easily reduceable compounds) were incorporated in some German NG smokeless propellants in order to protect the inside of gun barrels from erosion.

Z-Salz the name given to Na or Ca permanganates used as oxidizing components of rocket propellants in which T-Stoff served as a combustible component. A-Salz was used in the Feuerlilie type guided missiles called Hecht. Reference: F.Ross, Jr, Guided Missiles, Rockets and Torpedoes, Lothrop etc N Y (1951), pp 45-46.

Z-Stoff C. An aqueous soln of calcium permanganate containing 600 g MnO_4 per liter. Sp gr 1.4 at 20° and fr p -22°. Used as a catalyst, as described below (CIOS 30-115, p 10).

Z-Stoff N. An aqueous soln of sodium permanganate containing 600 g of MnO_4 per liter. Sp gr 1.4 at 20° and fr p -80°. Used as a liquid catalyst in liquid rocket propellants to assist the decomposition of hydrogen peroxide which served as a source of oxygen (CIOS 30-115, pp 8 & 10).

Note: Z-Stoff N was used in summer since its fr p is -8°, while Z-Stoff C was used in winter (fr p -22°). When Z-Stoff C or N is used to decompose the T-Stoff (hydrogen peroxide) the gaseous products contain besides water vapor and oxygen some small particles of manganese dioxide. Due to the presence of these particles, the gaseous mixture thus produced is not suitable for driving a turbine but can be used for other purposes such as in assisted take-off units and in rockets. When it is necessary to obtain a gaseous mixture free of MnO_2 the decomposition of H_2O_2 is conducted by means of a solid catalyst, such as described under MP-14.

Zünder. See Fuze.

Zündersprengkapsel-43. A separate cap and detonator assembly designed for use in some A/T mines in conjunction with a tilt type igniter, called Kippzünder 43 [TM 9-1985-2 (1953)].

Zündkraft. See Initiirvermögen.

Zündpatronensatz. See Cartridge Case Percussion Primer.

Zündsatz (Priming Composition). See Primary and Initiating Compositions.

Zündschnuranzünder (Igniter or Lighter for Fuse). Beyling-Drekopf (1936), pp 166-69, describes several types of igniters. Some of them are intended for use in firedamp-free mines (für Schlagwetterfreiegruben), while others for gaseous mines (für Schlagwettergruben).

Zündstoffe oder Initialexplosivstoffe (Priming, Igniting or Initiating Compounds). See Primary and Initiating Compositions.

Zündverstärker (Ignition Intensifier). Ignition of a propellant in 50 to 280 mm weapons was accomplished by means of a primer combined with an igniter contg about 2 g black powder. For larger guns, an extension, called Zündverstärker was fixed in front of the primer. This was filled with large grains of black powder and had a venturi at the forward end to throw the flame the full length of the charge. There were also one or two small side holes to ignite the rear of the charge as well.

Reference: CIOS 31-68 (1946), p 7 (See also under Ignition).

Zunehmender Drall. See Progressive Rifling.

Zusammengesetzte Zünder (Composite Igniters or Primers) are described in Beyling-Drekopf (1936), p 174.

Zwischenladung, Zwischenzündladung, oder Zwischenzünder (Intermediate Charge or Booster) is described in A.Stettbacher, Schiess- und Sprengstoffe, Leipzig (1933), p 352.

Zwischenzünder. See Zwischenladung.

Zwischenzündladung. See Zwischenladung.

VOCABULARY OF GERMAN ORDNANCE, AMMUNITION AND RELATED TERMS WITH SOME ABBREVIATIONS

(In collaboration with H. A. Tisch and J. F. Houck of Picatinny Arsenal, Dover, New Jersey)

A

Abbau	Mining(ore); dismantling(structure); decomposition
Abbildung (Abb)	Illustration; figure; diagram
abblasen	to release gas
abbrechen	to break off; cease
abbremsen	to brake; stop
abbrennen	to burn off; deflagrate; finish burning
abdampfen; abdunsten	to evaporate
Abdrift	Drift
abdrücken	to pull a trigger; fire
Abfallsäure	Waste acid
Abfeuern	Firing
Abfeuerungsvorrichtung	Firing mechanism; release mechanism (Mor)
Abgang	Discharge
Abgangsfehler	Jump; vertical jump(Arty)
Abgangswinkel	Angle of departure
Abgase	Exhaust gases
abgiessen	to cast metal; pour off; decant; spray chem warfare agents
abknallen	to explode; go off; fire off
abknistern	to decrepitate
Abkommen	Deviation; point of aim (at time of firing)
Abkommrohr	Subcaliber tube (G)
Abkommschiessen	Subcaliber firing
abkühlen	to cool
Abkürzung	Abbreviation
Ablage	Dump; depot
Ablagerung	Storage; deposit
Ablenkung	Deflection; deviation
Abnahme	Acceptance; decrease
Abnahmeprüfung	Acceptance test
Abnahmevorschrift	Specification
abnutzen	to wear out
Abnutzung des Rohres	Bore erosion (G); (see Ausbrennung des Rohres)
Aböl	Waste oil
Abpraller	Ricochet
Abprallwinkel	Angle of ricochet
Abprodukt	Waste product; by-product
Abreissknopf	Fuze-cord button (HdGr)
Abreiss-schlaufe	Firing cord loop (HdGr)
Abreiss-schnur	Fuze cord; lanyard
Abreisszünder	Friction igniter; ripcord igniter
Abrüstung	Disarmament
Absaugentfeuchter	Vacuum desiccator
Abscheider; Abscheidungsvorrichtung	Separator
abschiessen	to shoot down; discharge; fire
abschleppen	to tow
Abschleudermaschine	Centrifuge; catapult (See also Schleudermaschine)
abschleudern	to throw with a sling
Abschmelzdraht	Fuze wire; fusible wire
abschmieren	to grease; lubricate
Abschnitt	Sector; area
Abschrägung	Sloping; slope; bevel; taper
Abschuss	Discharge
Abschussrohr	Projector (CWS)
absehen	to see; aim; take sight at
Abspaltung	Splitting off; cleavage; separation
absprengen	to blast; burst
Abstand	Distance
Abstandsladung H15	Prepared hollow charge, 15 kg Hexogen (RDX), equipped with three legs to provide the desired stand off distance
Abstandwerfen	Pattern bombing
Abstandzünder; Radiogesteuertezünder	Radio proximity fuze; VT fuze
Abstellbahnhof	Railroad yard
Abteilung	Detachment; unit:
Abwehr	Active defence; military security
Abwehrgeschütz	Defense gun; AA gun
Abwehrleuchtzeichen	Alarm flare
Abweichung(des Geschosses)	Deviation; drift(Proj)
Abweiser	Cartridge case deflector protector
Abwerfen	to drop; jettison
Abwurf	Release (bombing)
Abwurfbehälter	Aerial bomb container
Abwurfgerät; Abwurfvorrichtung	Bomb release mechanism
Abwurfmunition	Drop ammunition such as aerial bombs, mines, torpedoes and some pyrotechnic items.
Abwurfrauchzeichen	Aricraft smoke signal (lit Drop-smoke-signal)
Abwurfschacht	Bomb rack
Abwurfsehrohr; Abwurfzielgerät	Bomb sight
abziehen	to pull (a trigger); draw off

Abzug	Trigger
Abzugsgang	Trigger pull
Abzugsschnur	Firing line; lanyard
Abzugvorrichtung	Trigger mechanism; firing mechanism
Abzweigung	Branch; junction (RR)
Acetessigäther; Acetessigester	Ethyl acetate
Acetsäure	Acetic acid
Achse	Axis; axle
Adamsit; DM	Adamsite; diphenylaminochloroarsine
Adolf (Kanone)	406 mm coast defense cannon
Aether	See Äther
Ago	Name of an aircraft manufacturing company
Akazin	Gum arabic
Akja	Boat type runner placed under gun wheels for operation in deep snow; (also used as a swamp conveyance for wounded, etc)
Akkumulator	Storage battery; accumulator
Aktiengesellschaft (A.-G.)	Joint Stock Company; Open Corporation
Alarmpistole	Alarm pistol; blank pistol
Alarmschussgerät	Trip-wire alarm flare equipment
Alarmschusspatrone	Trip-wire alarm flare cartridge
Alkalipatrone	Alkali - cartridge (oxygen breathing apparatus)
alkalisch (alkal)	alkaline
Alkalität; Alkalizität	Alkalinity
Alkohol (Alk)	Alcohol; ethanol
allgemein	general; common
Amboss	Anvil
Ammon	Ammonium; ammonia
Ammoniak	Ammonia
Ammonpulver	Ammonal
Ammonsalpeter	Ammonium nitrate
Ammonsalpeter - Sprengmittel	Ammonium nitrate explosive
Amorce (see also Zundhütchen)	Paper percussion cap (toy pistols)
Amphibienkampfwagen	Amphibian combat vehicle
Amt	Office; post; employment; business
Anfangsdrall	Initial twist of rifling
Anfangsdruck	Initial pressure
Anfangsgeschwindigkeit	Initial (muzzle) velocity
Anfangsladung	Initial charge
Anfeuchtung	Moistening; damping; humidifying
Anfeuerung	Combustible composition in a flare cartridge; ignition
Anfeuerungssatz	Fulminating compound; booster charge; igniter train
Anführungszeichen	Quotation marks
Angriff	Attack
Anhänger (Anh); Anhängewagen	Trailer
Anhydriesierungsmittel	Dehydrating agent
Anker	Anchor; armature; rotor
Ankermine	Anchored mine; moored mine
Anladung; Primärladung	Top (primary) charge of a blasting cap or a detonator; primer
Anlage	Installation; annex; plant; design
Anlasser	Starter
Anlaufgeschwindigkeit	Starting (take off) speed
Anlegepunkt	Aiming point
Annäherung	Approximation; approach
Anpassung	Adaptation
Anrufzeichen	Call signal
Ansäuerung	Acidification
Ansaugung	Suction
Anschlag	Impact; stroke; aiming or firing position
Anschiesspatrone (See also Anwärmeschuss and Einschiessgeschoss)	Cartridge used for adjustment fire and for warming up a gun; warmer
Anschluss	Joining; junction; connection; something annexed; liaison
Anschlussbahnhof	Railroad junction
Anschuss	Sighting shot
ansetzen (das Geschoss)	to ram
Ansetzer	Rammer; ramrod (G)
ansprengen	to blow up; blast
Ansteckmagazin	Detachable magazine
Anstellwinkel	Angle of yaw
Anstoss	Collision; impulse
anstürmen	to attack; assault, charge
anvisieren	to take aim; to sight
Anwärmeschuss	Warming - up shot
Anwendung	Employment; use
Anzahl (Anz)	Number; quantity
Anzahl der Nuten	Number of grooves
Anzeiger	Index; indicator
Anzünder	Igniter; lighter
Arabin-gummi	Gum arabic
Arbeit	Work; labor; job
Arbeitsgeschütz	Roving gun (Arty)
Armee	Army (a tactical unit above Army Corps, distinguished from Heer, the Army)
Armeerevolver	Service revolver
Arsenal; Zeughaus	Arsenal
Arsin	Arsine (CWS)
Art	Kind; sort; variety; species; pattern; type; manner
Artillerie (A)	Artillery
Artillerie, leichte (A)	Light artillery
Artillerie, schwere (sA)	Medium artillery (lit Heavy)
Artillerie, schwerste (ssA)	Heavy artillery (lit Heaviest)
Artilleriewesen	Gunnery; Ballistics (See also Schiesswesen)
Arznei; Arzneimittel	Drug; medicine
Arzt	Doctor; physician; medical officer
Ast der Flugbahn	Branch of trajectory
Atemgerät	Oxygen apparatus (lit Breathing apparatus)
Äther	Ether
Äthylarsindichlorid	Ethyldichloroarsine (CWS)
Äthyldichlorarsin	Ethyldichloroarsine (CWS)
ätzender Kampstoff	Blister gas (CWS)
Ätznatron	Caustic soda (NaOH)
äussere Ballistik	External Ballistics
äussere Weite (aW)	External diameter (ED)
Atmosphäre (Atm)	Atmosphere
Atombombe	Atomic bomb

Aufbau	Building up; structure; superstructure, i e sponson and turret (Tk) synthesis
aufbauchen; aufbauschen	to swell up; puff up
Aufbauchung	Bulge; swelling
aufbrauchen	to consume; use up
aufbrausen	to effervesce
aufbrechen	to break up; burst; open up
aufdunsten; aufdünsten	to evaporate
Auffangvorrichtung	Buffer
Aufforderungssignal (AS)	Call signal
Aufklärungspanzer	Light armored reconnaissance vehicle (See also Panzerspähwagen)
Aufladung	Detonating (base) charge of a cap
Auflöslichkeit	Solubility
Aufnahme	Photographic picture
Aufplatzen	to explode; burst open; blow up
Aufsatz	Rear sight; telescope mount
Aufschlag	Impact; percussion; shock
Aufschlaggeschoss	Impact (percussion) projectile
Aufschlaggranate	Impact(percussion)shell
Aufschlagzünder (AZ)	Impact (percussion) fuze
Aufschlagzünder mit Verzögerung (AZmV)	Impact (percussion) fuze with delay
Aufschlagzünder ohne Verzögerung (AZoV)	Impact fuze without delay
aufschrauben	to screw in
Aufspaltung	Splitting up; cleavage (of compounds)
aufsprengen	to blow (blast or force) open
Aufsteckmunition	Semi-fixed ammunition
aufsteigender Ast	Ascending branch (of trajectory)
Auftaupunkt	Thaw point
Auftreff	Impact; collision
Auftreffgeschwindigkeit	Terminal velocity; striking velocity
Auftreffpunkt	Impact point; striking point
Auftreffwinkel	Angle of impact; angle of incidence
Aufzug	Elevator
Augenblicks-	Instantaneous
Augenblickszünder	Instantaneous nondelay fuze; quick fuze
Augenblickszünder mit Verzögerung	Instantaneous fuze with delay
Augenreizstoff	Lacrimator (CWS)
Ausbau	Construction; dismounting (G)
Ausbauchung	Expansion; swelling; enlargement
Ausbeute	Yield; crop; output
Ausbläser	Deflagration without detonation
Ausblühung	Efflorescence
Ausbohrung	Bored hole; bore of rifle
Ausbrennen	to burn out rifling; erode
Ausbrennung des Laufes; Rohrabnutzung	Erosion of the bore (G) (See also Abnutzung des Rohres)
Ausdampfung	Steaming out
Ausdehnung	Expansion
Ausdunstung; Ausdünstung	Evaporation; vapor
Auseinandernehmen	Taking apart, stripping
Ausfall	Precipitation; falling out
Ausführung (Ausf)	Design; model; execution
Ausgang	Exit; departure; start
Ausgleicher	Compensator; equilibrator
ausglühen	to anneal; to ignite
Ausguss	Lip; spout; casting
Ausgussmörser	Lipped mortar
aushärten	to temper; harden
auslöschen	to extinguish; put out (fire)
Auslöseeinrichtung	Release mechanism (bombing)
Auslösehebel	Release lever
auslösen	to uncouple; release
Ausnahmeladung	See Sonderladung
Ausnutzungskoeffizient	Utilization coefficient; efficiency
Ausreisser; Fehlschuss	Stray shot
Ausrüstung	Equipment; armament; outfit
ausschiessen (Lauf)	to wear out the gun; to score the bore
Ausschnitt	Cut; notch
Ausschwitzung	Exudation
äussere Ballistik	External Ballistics
Aussprungwinkel	Angle of reflection
Ausstossbuchse	Smoke canister ejected from projectile on burst
Ausstossen	to expel, eliminate
Ausstossladung	Expelling charge of a projectile; burster
Ausstossrohr	Ejecting tube; torpedo launching tube
Austrockner	Desiccator
auswiegen	to weigh out; calibrate by weight
Auswahl	Choice; selection
auswalzen	to roll out
auswärmen	to anneal; roast
Auswaschflasche	Wash bottle
Abwechselbar; austauschbar	interchangeable
auswechselbares Seelenrohr	Removable (interchangeable) liner in a gun
Ausweg	Way out; outlet
Ausweichung	Deviation; deflection; detour
Ausweis	Proof; evidence; report
Auswerfer	Ejector (Ord)
Auswertung	Valuation; value
Auswitterung	Efflorescence; detection by odor
ausziehen	to extract
Auszieher	Extractor (Ord)
Autofrettage	See Kaltstreckung
Automat	Automat
automatische Mine	Automatic mine
automatisches Gewehr	Automatic rifle; submachine gun
Axe; Achse	Axis
Azetylensauerstoffbrenner	Oxacetylene torch
Azot; Stickstoff(N)	Nitrogen

B

Backbord	Port side
Bahn	Way; road; railroad; trajectory
Bahnhof	Railroad station
Bajonett	Bayonet(See also Seitengewehr)

Bajonettverbindung	Bayonet joint
Bake	Beacon; navigation guide
Balkenlafette	Beam gun carriage
Balkenwage	Beam balance
ballistischer Beiwert	Ballistic coefficient
ballistischer Pendel	Ballistic pendulum
Ballon	Balloon; carboy
Bandelier	Bandoleer; shoulder-belt
Bär	Bear (One of the tanks)(See under Panzer)
basisch(bas)	basic
Batterie	Battery(Arty); accumulator
Bauart	Type of construction
Baujahr	Year of construction
Baumegrad; Be	Degree Baumé; Bé
Baumwollabfall	Cotton waste; cotton linters
Baumwolle	cotton
Bausoldat	Soldier in a construction unit
Beamter; Beamte	Official; civil servant
Beanspruchung	Strain; straining
Becher	Beaker
Bedienung	Gun squad; gun crew; service
Bedruckung	Printing; impression
Befehl	Order; command
Befeuchtung	Moistening; dampening
Begleitartillerie	Accompanying artillery
Begleitgeschütz	Accompanying gun
Behälter	Container; gasoline tank
Beharrungsvermögen	Inertia; force of inertia
Beheizung	Heating
Behelfsmine	Makeshift mine
Beiheft	Supplement (The word is sometimes used in titles in journals such as Kolloidchemische Beihefte)
Beihilfe	Help; assistance
Beiladung	Supplementary (increment) charge (such as in non-fixed ammunition); booster charge; ignition charge
Bein	Leg
Beispiel	Example
Beisszange	Nippers; pinchers
Beitrag	Contribution; share
Beiwagen(Beiw)	Side car
Beiwart	Coefficient
Beize	Corrosive; corrosion
Bekapseln(der Patronenhülsen)	Priming(of cartridge cases)
bekapselte Hülse	Primed cartridge case
bekupfern	to copper
Beladen; Beladung	Loading; charging; load; cargo
Belagerung	Siege
Belagerungsgeschütz	Siege gun
Beleuchtung	Lighting; illumination
Belgien	Belgium
Belüftung	Ventilation
Benzin	Gasoline
Benzol	Benzene
Beobachtungsmine	Observation mine
Beobachtungspatrone(BPatr)	Cartridge with a smoke producing projectile used for adjustment fire
Beplattung(des Zünders)	Fuze cap.
Berg	Mountain
Bergart; Bergbau(Bgb)	Mining
Berger-Mischung	Berger-type smoke agent (Zn dust 40 and hexachloroethane 60%)
Berggeschütz(BG)	Mountain gun (See also Gebirgsgeschütz)
Bergmann	Miner
Bergwachs	Mineral wax; ozocerite
Bergwerk	Mine(coal, ore, etc)
Bergwerksprengmittel	Mining explosive
Bergwetter	Damp (Mining)
Bergwolle; Steinflachs Asbest	Mineral wool; asbestos
Bericht	Report; notice; information
Bernstein	Amber
Bernsteinsäure	Succinic acid
berittene Artillerie	Horse artillery
bersten	to burst; explode
Berücksichtigung	Consideration; regard
Beruf	Calling; occupation
Besatz	Stemming; tamping(See also Verdämmen)
Besatzung	Garrison; crew
Besatzungsheer	Army of occupation
Beschädigung	Damage; injury
Beschaffung	Procurement(A division of Heereswaffenamt in charge of procurement of amterials and finished articles)
Beschäftigung	Occupation; business
beschiessen	to proof fire; to cannonade
Beschiessung	Bombardment
Beschuss(Bs)	Firing-shooting; proof fire
Beschusspatrone(BsPatr)	Proof round (high pressure)
beschuss-sicher	bulletproof
beschützen	to protect
Beselersteg	Footbridge; hasty trestle (named after General H. von Beseler: 1850-1921)
Besetzungsarmee	Army of occupation
besonders(bes)	especially; singularly
bespanntes Geschütz	Horse-drawn gun
Bessemerstahl	Bessemer steel
Bestand	Stock; (supplies; equipment); inventory; strength
Beständigkeit; Stabilität	Stability (See also Haltbarkeit)
Bestätigung	Confirmation
Bestimmung	Determination
bestreichendes Feuer	Grazing fire(Arty)(See also Strichfeuer)
Bestückung	Armament(AC or Tk)(See also Bewaffnung)
Beton(Be;Bet)	Concrete(made with cement)
Betonbombe(BetB)	Concrete bomb
Betonbunker	Concrete pillbox
Betongranate(Betgr)	Anticoncrete shell(See also Granate Beton)
Betonturm	Concrete turret(Fort)
Betriebsanlage	Plant; works
Betriebsbereich	Limits of operation
Bettung(Bett)	Platform(RR G); base (Fixed G); foundation
Bettungsgeschütz	Platform gun
Beute	Booty; captured materiel; loot
Beutegeschütz	Captured gun
Beutel	Bag; pouch

Beutelkartusche	Propellant charge in a bag
Bewaffnung	Armament; equipment
beweglich	mobile; movable; flexible
bewegliches Geschütz	Flexible gun
bewegliche Scheibe	Moving target
bewegliches Maschinengewehr	Mobile (flexible) machine gun
Beweglichkeit	Mobility; maneuverability
Bewegungskrieg	Mobile warfare
Bewetterung	Ventilation (Mining)
Bezirk(Bez)	District
beziehungsweise(bzw)	respectively; or
Bezug	Datum; reference; relation
bezüglich	referring to; with reference to
Bild	Image; figure
bildsam	plastic; flexible; ductile
Bildungswärme	Heat of formation
Bindemittel	Binding agent or material; adhesive
Binitrotoluol	Dinitrotoluene
Biwak	Bivouac
blank	bright; clear; smooth; blank
blanke Waffen	Hand weapons; armes blanches
Blasangriff	Cloud attach; cloud gas attack
blasenziehender Kampfstoff	Vesicant agent(CWS)
Blatt	Leaf; blade; sheet
Blättchen	Lamina; leaflet; flake; lamella
Blättchenpulver(BlP)	Rectangular flake propellant
Blaukreuz(BlK)	Blue cross(sternutators)(CWS)
Blaupause	Blueprint
Blausäure	Hydrocyanic acid(HCN)(CWS)
Blech	Sheet metal
Blechbüchse	Sheet metal container; tin can
Blei	Lead
bleichen	to bleach; whiten
Bleidraht	Lead wire(used for decoppering gun tube)
Bleigeschoss	Lead bullet
Bleimantelgeschoss	Lead-jacketed bullet
Blendbombe	Dazzle bomb
Blende	Gun mantlet; gun shield
Blendkörper(BK 1)	Frangible glass smoke grenade; glass bottle grenade
Blendungsschiessen	Smoke-screening fire(Arty)
blind	blind; dull; inert
Blindgänger; Bodenkrepierer	Dud
blindgeladen	loaded with blank ammunition
blindgeladene Granate	Blank shell
Blinkgerät; Blinklampe	Signal lamp
Blitzkrieg	Blitz war; lightning war
Blitzlichtbombe; Blitzlichtcylindrische Bombe(BLC)	Photoflash bomb; photographic flash bomb, cylindrical
Blitzschutz	Lightning protection
Blockverschluss	Block action; block-lock
Boden	Ground; earth; base; container for bombs (such as described in TM 9-1985-2, p 117)
Bodenabstandszünder	Base delay-action fuze
Bodenabwehr	Ground defense; AA defense
Bodenanlage	Ground installation
Bodenaufschlagzünder (BdAZ)	Base percussion fuze
Bodenkammer der Granate	Base chamber; rear burster of a projectile
Bodenkammerladung	Base charge(Ammo)
Bodenkammerschrapnell	Shrapnel with rear burster
Bodenkanzel	Ball turret; ventral turret (Ap)
Bodenkappe	Base cap; bottom plate
Bodenkrepierer	Dud
Bodenlafette(Bola)	Ventral gun mount (Ap)
Bodenplatte	Base plate (Mor)
Bodenrand	Flange; rim
Bodenreisser(der Hülse)	Split base; ruptured base (of a case)
Bodenrang(der Patronenhülse)	Rim(of a case)
Bodenschwanz	Tail(of a bomb); breech end; breech ring(G); butt assemlby (MG)
Bodenstücke	Outrigger support (G)
Bodenziel	Ground target
Bodenzünder(BdZ)	Base detonating fuze(BDFz)
Bogen	Bow; arc; bend; curve
Bogenschuss	Curved fire; high-angle fire
Bogenspitze	Ogive (Ammo)
Bohrgeschoss	APHE projectile (HE charge exploded after the armor or concrete was pierced)
Bohrladung	Borehole blasting charge
Bohrloch; Minenrohr	Borehole
Bohrpatrone	Blasting cartridge; prepared charge; demolition charge
Bohrpatrone 88 (BhrPatr 88)	Demolition cartridge type 1888 (containing picric acid)
Bohrpatrone 02(BhrPatr 02)	Demolition cartridge, type 1902 (containing 75g of TNT)
Bohrpatrone 28 (BhrPatr 28)	Demolition cartridge, type 1928 (containing 100g of TNT)
Bohrung	Bore; caliber
Bolzen	Bolt; peg; striker; firing pin; crossbow bolt
Bolzenblech	Washer; rosette (Arty)
Bolzenbüchse	Compressed air gun
Bombard	Great gun; bombard
Bombardierung; Bombardement	Bombing; bombardment
Bombe	Bomb
Bombe in Felder eingeteilt	Segment bomb; fragmentation bomb
Bomb mit Verzugszeit	Time bomb
Bombenabwurf; Bombenauslösung	Bomb release
Bombenbündelträger	Bomb cluster carrier; cluster adapter
Bombenfallkurve; Bombenflugbahn	Bomb trajectory
Bombenkopf	Bomb nose
Bombenlast	Bomb load
Bombenschacht	Bomb rack
Bombensplitter	Bomb fragment
Bombentorpedo	Torpedo bomb
Bombenträger; Bombengalgen	Bomb carrier; bomb rack
Bombenvisier; Bombenzielgerät	Bomb sight

Bombenzünder	Bomb fuze
Boot	Boat; hull(of a flying boat)
Bördelung	Crimp; crimping
Bordkanone(BK)	Gun on ship or airplane
Bordlafette(BL)	Gun mount on ship or airplane
Bordland Fackel, weiss	Beach flare, white
Bordmunition	Aircraft ammunition
Bordwaffen	Aircraft armament; tank armament
Borsäure	Boric acid
Böschungswinkel	Angle of slope
Bouteille; Flasche	Bottle
Boxe	Submarine pen
Brand(Br)	Fire; incendiary; gangrene
Brandbombe(BrB)	Incendiary(Inc) bomb
Brandbombenbündel	Cluster of incendiary bombs
Brandflasche(such as ½ and ¼ liter)	Frangible incendiary grenade; glass bottle incendiary grenade; "Molotov Cocktail"
Brandgeschoss(BrG)	Incendiary bullet; incendiary projectile
Brandgranate(BrGr)	Incendiary shell
Brandgranate mit Leuchtspur (Brgr mL'spur)	Incendiary shell with tracer
Brandgranate ohne Leuchtspur(Brgr oL'spur)	Incendiary shell without tracer
Brandkerngeschoss	Incendiary bullet
Brandkuchen	Incendiary composition
Brandloch	Vent; flash hole; flame passage
Brandmittel; Brandstoff	Incendiary Agent
Brandmunition	Incendiary ammunition
Brandpanzergranate(Brpzgr)	AP Inc projectile
Brandpfeil	Incendiary arrow
Brandsatz-Brandzeug	Incendiary composition; Incendiary filling
Brandsprenggranate(Brsprgr)	HE-Inc projectile
Brandstab	Incendiary rod (used for destruction of documents, etc)
brandwirkend	incendiary
Braunack	Liquid used in recoil mechanism
Braunkohle	Lignite; brown coal
Bräunierung	Burnishing; browning
Braunstein	Manganese dioxide(lit Brown stone)
Braunpulver	Brown powder
Brause	Effervescence; shower
Brechung	Breaking; refraction
Breite	Width
Breitenfeuer	Sweeping fire
Breitenstreuung	See Querstreuung
Bremse	Brake; buffer(also Rohrbremse)
Bremsrohr	Brake tube
brennbar	combustible; burnable
Brenndauer	Duration of burning; burning time(Fz, etc)
Brenngemisch	Liquid combustion mixture, such as gasoline
Brenngeschwindigkeit	Burning rate(Fz, etc)
Brennschluss	End of burning

Note: According to W. Dornberger, V-2, Viking Press, N Y (1954), pp 9-14 the above word is used in liquid rockets to signify the moment of disappearance of the flame issuing from the tail of a rocket. The English term "all burnt" is not correct, because at Brennschluss considerable quantities of fuel may still be left in the tanks.

Brennstoff	Fuel; gasoline; Diesel fuel; combustible
Brennzünder(BZ)	Powder-train fuze (Sh); time fuze(HdGr)(lit Burning fuze)
Brennzünder 24	Friction type igniter (4½ seconds)
Brenz-	Pyro-
Brenzcatechin	Pyrocatechol
Brenzweinsäure	Pyrotartaric acid
Brettstückmine	Pressure-board land mine
brisanter Sprengstoff; Brisanzsprengstoff	High explosive; disruptive (brisant) explosive
Brisanz	Shattering power; brisance
Brisanzgranate	High explosive(HE)shell
Brisanzmunition	HE ammunition
Brisanzschrapnell	HE shrapnel
Brisanzsprengstoff; Brisanzpulver	HE; brisant powder
Brombenzylcyanid	Brombenzylcyanide(CWS)
Bromzyan	Cyanogen bromide(CWS)
Bruch	Fracture; rupture; crash (of a plane)
Bruchlandung	Crash landing
Bruchprobe	Breaking test
Bruchstück; Splitter	Fragment
Brücke	Bridge; platform
Brückenglühzünder	Electric(bridge-wire) of blasting cap (lit Incandescent bridge-wire igniter)
Brückenzünder	Bridge-wire igniter; electric blasting cap
Brumbär	Grizzly Bear (SP weapon) (See under Panzer in descriptive part)
Bruno N Kanone	280 mm Railway Gun (See under Weapons)
Brustschild	Breast shield (G); chest protector
Brustwehr	Breastwork; parapet
Bruttogewicht	Gross weight
B-Stoff	Bromaceton(CWS)
Buchse(Bu)	Bushing; jack; socket(Rad)
Büchse(Bü)	Shotgun; canister; tin can; rifle
Büchsenhandgranate 42(*)	Norwegian, box type, hand-grenade 42
Büchsenkonserven	Canned food; canned ration
Büchsenpulver	Rifle propellant
Bug	Bow; front; nose
Bügel	Trigger guard
Buggeschütz	Bow gun; front gun

Bugpanzer	Front armor
Bunareifen	Buna tire; synthetic rubber tire
Bund	Band; tie; bundle; alliance
Bündel	Bundle; cluster(bombing)
Bunker	Concrete emplacement; concrete pillbox; shelter; submarine pen
bunt	varicolored; bright; dazzling
Buntkreuzmunition; Buntmunition	Ammunition used for Buntkreuzschiessen (qv) (lit Multicolored cross ammunition)(CWS)
Buntkreuzschiessen	Simultaneous firing of different poison gases from separate guns. The gases used were a mixture of Weisskreuz, Gelbkreuz and Grünkreuz, sometimes together with Blaukreuz or Schwarzkreuz (CWS)
Buntrauch(Bunr)	multicolored smoke
~~Buntschiessen~~	~~Shooting with HE and chemical~~ shell
Bussole	Compass
Bütte	Tube; vat

C

Celsiusgrad(C)	Centigrade
Ce-Stoff	Cyanogen bromide(CWS)
C-Geschoss	Streamlined shell
Chaussee	Highway
Chemie	Chemistry
Chemische Kampfstoffe	Chemical warfare agents(CWS)
chemisch-mechanischer Zünder 41(CMZ 41)	Chemical-mechanical igniter 41
chemischer Krieg	Chemical warfare(CW)
chemischer Zünder "Buck"	Chemical crush igniter "Buck"
chiffrieren	to cipher; code
Chloramin	Chloramine-T (CWS)
Chlorarsinkampfstoff (Clark I)	Diphenylchlorarsine(CWS)
Chloratsprengmittel	Chlorate explosive
Chloracetophenon-Chlorpikrin-Lösung	Chloracetophenone-Chloropicrin solution(CWS)
Chlorcyan	Cyanogen chloride(CWS)
Chlorgas	Chlorine gas(CWS)
Chlorkalk	Chlorinated lime $(CaOCl_2)$ (CWS)
Chlorkohlenoxyd	Phosgene; carbonylchloride(CWS)
Chlorpikrin	Chlorpicrin(CWS)
Chlorsulfonsäure	Chlorsulfonic acid(CWS)
Chlorvinyldichlorarsin	Lewisite(CWS)
Chlorwasserstoffsäure	Hydrochloric acid
Clark I	See Chlorarsinkampfstoff
Clark II; Cyan Clark	See Cyanchlorarsinkampfstoff
Construktion(C)(old spelling)	Type; pattern; brand (See also Konstruktion)
Conto	Account
Conus	Cone
Cyanchlorarsinkampfstoff (Clark II)	Diphenylcyanarsine(CWS) (See also Schwarzkreuz)
Cyanwasserstoff	Hydrocyanic acid

D

Dach	Roof
Dachkorn	Triangular front sight
Dachluke	Turret hatch(Tk)
Dampf	Vapor; steam
Dämpfer	Damper; flash hider(G)
Dampfmaschine	Steam engine
Dampfrohr	Steam pipe
Dampfspannung	Vapor pressure
Darstellung	Preparation; production; manufacture
Dauerfeuer	Continuous fire; automatic fire; fire for effect
Dauerprobe	Resistance test; continuous test
Dauerprobe eines Laufes	Endurance test of a barrel
Dauerschussfeuer	Sustained or automatic fire
Deckblättchen	Top wad; overshot wad
Deckel	Cover
Deckung	Cover; shelter
Deckungsloch	Foxhole
Degen	Sword
Dehnung	Extension; expansion
Deich	Dyke
Demolierung	Demolition
demontieren; von der Lafette nehmen	to dismount a gun
Demontiergeschoss	Demountable projectile
Denitrierung	Denitration
Detonationsdruck	Blast pressure
Detonationsfähigkeit	Ability to transmit detonation throughout the mass of an explosive, as determined in Germany by the "Four-Cartridge Test"
Detonationsgeschwindigkeit	Velocity of detonation(expressed in meters per second)
Detonationstemperatur	Temperature of detonation
Detonationsübertragung	Ability to transmit detonation by influence from one cartridge to another placed some distance away (as determined by the Gap Test described in the general section)
Detonationswelle	Same as Explosionswelle
Detonator	Detonator
deuten	to indicate; explain; interpret
Deutgeschoss(Deut-Gesch)	Projectile giving on a burst a cloud of colored smoke serving as indicator; indicator projectile
Deutpatrone(DeutPatr)	Indicator cartridge(such as for grenade pistol)
Deutschmark(DM)	See Reichsmark
Deutung	Interpretation; explanation
Dichte; Dichtigkeit	Density
Dichtung	Packing; joining; obturation
Dichtungsdeckel	Sealing cover(See also Fliessdeckel)
Dichtungsplatte	Obturating plate
Dichtungsring	Obturating ring; gas-check ring
dick	thick; dense
dickwandig	thick-walled
Dienstwaffe	Service weapon
Diglykolnitrat-Blättchenpulver	Diethyleneglycol dinitrate (DEGDN) flaked propellant

Diglykolnitratpulver(Dig P)	DEGDN propellant
Diphenylchlorarsin	See Chlorarsinkampfstoff
Diphenylcyanarsin	Diphenylarsine Cyanide, called also Cyanchlorarsinkampfstoff
Diskushandgranate	Hand grenade in the form of a disk
Dobgerät	Launcher for firing simultaneously up to 65 rockets, such as Taifun(TM 9-1985-3, p 223)
Docht	Wick
Do-Gerät 38	Launcher for 150 mm rockets (15 cm Wurfkorper 41 Spreng and Wurfgranate 41Nb)
Dolch	Dagger
Donaritpatrone 100 g	Demolition cartridge with 100g of Donarite
Doppelbüchse	Double-barreled rifle
Doppellafette	Two-barreled mount
doppelläufig	double-barreled
Doppelzünder(Dopp Z)	Time and percussion fuze (lit Double action fuze); combination fuze

Note: Fuze which contains a powder-train ignition element is called Pulverbrennzünder

Dora (Kanone)	Same as Sevastopol Gun, called also Gustav Geschütz
Draht(D)	Wire
Drahtnetz	Wire net; wire mesh
Drahtrohr	Wire-wound gun barrel
Drahtschere	Wire cutters
Drahtzange	Pliers(for handling wire)
Drall	Rifling twist (in a gun); spin (of a projectile); pitch of rifling
(gleichbleibender Drall)	(Uniform twist)
(zunehmender Drall)	(Increasing twist; progressive rifling)
Drallabweichung; Seitenabweichung	Drift (due to spin of projectile)
Dralllänge	Length of twist(rifling)
Drallwinkel	Angle of rifling; pitch of rifling
Drallzüge	Grooves(Rifling)
Drang	Throng; pressure; impulse
Dreh-	Rotary; rotating
Drehbank	Lathe
Drehkuppel	Revolving cupola
Drehscheibenlafette	Gun carriage on turntable
Drehturm	Revolving turret
Drehverschluss	Revolving breech mechanism
Drehzahl	Number of revolutions per minute (rpm)
Drehzahlmesser	Tachometer
Dreiachslafette	Triaxial mount (G)
Dreibein; Dreifuss	Tripod
Dreibeinlafette	Tripod gun mount
Dreiergemisch	Triple mixture (gasoline 50, benzene 40 and alcohol 10%)
Dreifachzünder	Triple-action fuze; combination fuze (superquick, delay and time)
Dreifusslafette	Tripod gun mount
Drilling	Three-barreled hunting gun, usually with two smooth bore and one rifled barrels
Druck	Pressure; compression; print
Druckbolzen	Buffer bolt
Druckfestigkeit	Compressive strength
Druckknopfzünder 42	Pushbutton-rocket igniter or snap igniter, pattern 42
Druckkugel	Land mine operated by pressure
Druckwelle	Pressure wave
Druckzünder 35(DZ 35)	Pressure fuze; pressure igniter push igniter, type 35
D-Stoff	Dimethylsulfate(CWS)
Dumdum Geschoss(DdG)	Dumdum bullet
Dunkelkammer	Darkroom
dünn	thin; dilute; slender
Dunst	Vapor; haze; smoke; fine shot; small shot; "dunst shot"
durchbrechen	to break through; pierce
durchbrennen	to burn out
Durchbruchkampfwagen	Land cruiser (lit Breaking through combat car)
Durchdringung	Penetration
durchladen	to load(a magazine or Belt)
Durchmesser (/)	Diameter
Durchschiessen; Durchschuss	Perforation
Durchschlag	Penetration; filter; screen; punch; carbon copy.
Durchschlagkraft	Force of penetration; perforating power
Durchschnitt	Average; mean; cross section
Durchschnittpanzerstärke	Average thickness of armor
Durchtränkung	Saturation; impregnation
Düse (Dü)	Injector; jet; nozzle; vent (Rocket)
Düsenjäger	Jet-fighter plane
Düsenrohr	Blast pipe
Düsenwaffe(DüW)	Jet-propelled projectile, such as Panzerfaust (lit Vent weapon)
Dynamitgeschütz	Pneumatic gun shooting projectiles filled with dynamite

E

E-100(Panzer)	One of the heavy tanks (See under Panzer)
Ecke	Corner; angle
Ei (pl Eier)	Egg
eichen	to calibrate
Eichung	Calibration; ajustment
Eierhandgranate	Egg-shaped hand grenade; pineapple handgrenade
Einabzug	Single trigger
Einäscherung	Incineration; complete combustion
Einbau	Mounting; installation
Einbruchsfeuer	Assault fire
Eindämpfung	Evaporation

Eindecker	Monoplane
Eindrehung	Slot; groove
Einhalsung der Patronenhülse	Neck of the cartridge case
eindringen	to penetrate; press in; infiltrate
Eindruck	Impression
einfach	simple
Einfallwinkel	Angle of impact
Einfeuer	Single shot fire
Einflussrohr	Inlet pipe
einführen	to adopt; introduce
Eingang	Entrance; introduction
Eingangszündung	Priming charge
Eingiessung	Pouring in
Einheit	Unit; unity
Einheitsgeschoss	Standard projectile; combined shell
Einheitsgeschütz	Universal piece; dual-purpose gun
Einheitsgewicht	Specific gravity
Einheitsgranate	Combination HE and shrapnel shell
Einheitsmunition	Fixed ammunition
Einheitspatrone	Standard cartridge
Einheitspulver(EP)	Standard propellant (See descriptive section)
Einheitswaffe	Dual-purpose weapon
Einheitszünder	Standard fuze; combination fuze
Einlage	Insert
Einlagerung	Storage
Einlaufgewehr	Single barrel gun
Einlegerohr	Subcaliber tube; liner
Einpressen des Geschosses in die Züge	Forcement of a projectile into rifling; engraving
einrasten	to engage; ram home; lock
einrichten	to adjust(fire, etc)
Einrichtung	Installation; establishment
Einsäuerung	Acidification
Einschiessen	Adjustment fire; trial fire; target(range) finding
Einschiessgeschoss (See also Anschiesspatrone and Anwärmeschuss)	Range finding bullet; projectile used for adjustment fire; round to locate target; "warmer"
Einschiessziel	Adjustment target
Einschiffung	Embarkation
Einschlag	Impact; strike
Einschnitt	Notch; cut
Einschuss	Hit
einsetzen	to commit; insert
Einspritzdüse	Injection nozzle
Einstecklauf; Einsteckrohr	Subcaliber tube; insert barrel; adapter
Einsteckmagazin	Detachable magazine
einstellen	to adjust or set(Fz, etc); cease fire; tune in(Rad)
Einstellring; Stellring	Adjusting ring(Fz)
Eintauchrefraktometer	Immersion refractometer
einvisieren	to sight in
Einzelladermagazin	Single-loading magazine(for repeating fire)
Einzellader	Single-loader; single shot weapon
Einzelschuss	Single shot; single round
Einzelschussfeuer	Single shot fire(in contrast to bursts)
Einzelsternpatrone	Single star cartridge
Eis	Ice
Eisenbahn(E)	Railroad(RR); railway
Eisenbahngeschütz	Railroad gun
Eisenbahnhaubitze	Railroad howitzer
Eisenbahnlafette	Railroad mounting(G)
Eisenbahnpanzerzug	Armored railroad train
Eisenbahnschiene	Rail
Eisenbetonbau	Reinforced concrete construction
Eisenblech	Sheet iron
Eisenwalze	Iron roller (in clearing of mines)
Eismine(EisM; EsMi) (See also Flascheneismine)	A/P bottle mine (lit Ice mine)
Eiweiss	White of egg; albumin
Elektron	Electron (trade name for Al-Mg alloy)
Elefant	"Elephant" tank destroyer (See under Panzer in descriptive part)
empfindlich	sensitive
empfindlicher Aufschlagzünder(EAZ)	Superquick impact fuze
empfindlicher Kopfzünder(EKZ)	Sensitive type of PD Fz; all ways fuze
empfindlicher Zünder(EZ)	Superquick fuze; high-sensitivity fuze (See also Schnellzünder)
Empfindlichkeit	Sensitiveness; sensitivity
Enddrall	Terminal twist of rifling
Enddruck	Final pressure
Ende	End; limit; termination
Endgeschwindigkeit; Restgeschwindigkeit	Terminal velocity; remaining velocity
Endwucht	Remaining energy
Enge	Narrowness; closeness
Entenflinte	Duck gun
Entfernung(E)	Range; distance (See also Schussweite)
Entfernungsgerät; Entfernungsmesser; Entfernungszeiger	Range finder; range indicator
Entfeuchter	Desiccator
Entflammung	Inflammation; flash
Entflammungsprobe	Flash test
Entgiftung	Detoxication; decontamination(CWS)
entkupfern	to decopper
Entkupferungsmittel	Decoppering agent (such as Pb wire)
entlasten	to relieve (of pressure)
Entlastungszünder(EZ)	Antilifting igniter (with HE charge)
entlüften	to ventilate; to bleed recoil mechanism
Entriegelung	Unlocking
entschärfern(Zünder)	to unprime (Fz)
entsichern	to disengage or release the safety device (Wp); to arm or to activate (Mi or B)
Entsicherungsflügel	Arming vane(B)
entspannen	to uncock; to relieve tension; to let the firing pin down
entwaffnen	to disarm
entwässern	to free from water; dehydrate
Entwässerungsgraben	Drainage ditch
entzünden	to ignite
Entzündlichkeit	Flammability
Entzündungstemperatur	Ignition (inflammation) temperature

Erdartillerie	Artillery used against ground targets (as distinguished from AA Arty)
Erdbebenbombe	Earthquake bomb
Erde	Earth; soil; ground (electrical)
Erdmine; Landmine	Land mine
Erdöl	Petroleum
Erdziel	Ground target
Erforschung	Investigation; research
Ergänzung	Completion; supplement; replacement(s); reserve(s)
Ergebnis	Result; yield; score
Erhitzung	Heating
Erhöhung	Quadrant elevation(Guny)
Erkennung	Detection; recognition
Erklärung	Explanation; declaration
Ermüdungskampfstoff	Harassing agent(CWS)
Ermüdungsschiessen	Harassing fire; gas-shell fire
Erprobungsplatz; Waffenprüfungsplatz	Proving ground; place for testing weapons
Ersatz(Er)(See also Surrogat)	Substitute; replacement; synthetic material; spare part
Ersatzsprengstoffe(ErS)	Substitute explosive
Ersatzstück(Erst)	Spare part; inert piece resembling in appearance a fuze found in front section of some projectiles
Ersatzteil	Substitute part; spare part
Erschütterung	Concussion; shock
Erstarrung	Solidification; congelation
erstickender Kampfstoff	Asphixiating gas; lung irritant(CWS)
Erwärmung	Warming; heating
Erweichung	Softening
erwidern	to reply; return
Erwiderungsfeuer	Retaliation fire; counterfire
Erz	Ore; metal especially bronze
Erzeuger	Producer; generator; manufacturer
Esau	Nickname for 1000 kg, AP bomb; called in Ger "1000 kg SD"
Esche	Ash; ash tree
Esse	Forge; hearth; chimney; stack
Essig	Vinegar
Essigäther	Ethyl acetate
Essiggeist	Acetone
Essigsäure	Acetic acid
Exerzierbombe(ExB)	Drill(practice)bomb; dummy bomb
Exerziergeschoss(ExG)	Drill(dummy)projectile
Exerziermarsch	Training hike
Exerziermunition(ExMun)	Drill(dummy)ammunition
Exerzierpatrone(ExPatr)	Drill(dummy)cartridge
Expansionsgeschoss	Expanding bullet; hollow point bullet
explodierbar; explosibel	explosive; explodable
explodieren	to explode
Explosibilität	Explodability
Explosionsdruck	Explosion pressure
Explosionsfähigkeit	Explosibility
Explosionsgeschoss	HE projectile
Explosionskraft; Explosivkraft	Explosive force or power
Explosionsstoss	Explosive impact
Explosionstemperatur	Explosion temperature
Explosionswärme	Heat of explosion
Explosionswelle	Explosion wave; shock wave
Explosivgeschoss	Explosive bullet
Explosivstoff	Explosive; explosive substance
Exsudat	Exudate; exudation

F

Fabrik	Factory; works
Fach	Branch; department; trade; branch of knowledge
Fackel	Flare; torch
Faden	Thread; filament; string
Fadenpulver	String propellant
fahrbar	passable; transportable; portable
Fahrer	Driver (of a car)
Fahrgestell(Fg; Fgst)	Chassis
Fahrrad	Bicycle
Fahrzeug	Vehicle; craft
Fallblockverschluss	Drop hammer
Fallhöhe	Height of drop
Fallkessel	Precipitating vessel
Fallprobe	Drop test; impact test
Fallschirm(FS)	Parachute
Fallschirmbombe(FB)	Parachute bomb
Fallschirmgewehr(FGew)	Parachutist's automatic rifle
Fallschirmjägergewehr-42 (KFG-42)	Paratroop fully automatic rifle
Fallschirmleuchtkugel; Fallschirmleuchtbombe	Parachute flare
Fallschirmleuchtpatrone	Parachute-flare cartridge for signal pistol
Fallschirmpatrone für Windmessung	Cartridge with parachute for measuring wind velocity
Fallschirmrakete	Parachute rocket signal
Fallschirmrauchpatrone	Smoke signal cartridge with parachute
Fallschirmrauchzeichen	Parachute smoke signal
Fallwinkel	Angle of fall
Fällung	Precipitation
Fallzünder	Percussion fuze (lit drop fuze)
Fangnetz	Antisubmarine net
fangen	to catch; capture
Farbe	Color; dye; pigment
Faschine(Fasch)	Fascine (bundle of sticks for the strengthening of field fortifications)
Faser	Fiber; filament
Fassnebelzerstäuber	Smoke sprayer (barrel)
Faust	Fist; grasp
Faustfeuerwaffe	Hand gun
Faustpatrone	Fist Cartridge; HoC rocket (See description)
F-Boot	Tank landing craft
Feder	Feather; pen; spring
Federantrieb	Spring action (clockwork fuze)
Federkapsel	Cap over a spring
Federkraft	Elasticity
Fehler	Error; defect; miss
feinkörniges Pulver	Fine-grained propellant
Feld	Field; land(rifling); ground
Feldbahn(Feba)	Field railroad(narrow-gage)
Feldgeschütz(FGesch)	Field piece; field gun
Felder	Lands(Ord)
Felder und Züge	Lands and grooves(Ord)
Feldhaubitze(FH)	Field howitzer
Feldkanone(FK)	Field cannon

Feldpatrone(FPatr)	Field gun cartridge(Fix Ammo)
Feldpolizei(Fepo)	Field police
Feldscher	Army medic
Feldwebel(Fldw)	Staff sergeant (except in Arty & Cavy)
Feldzeuglager	Ordnance depot
Ferdinand	SP mount(See under Panzer)
fern	far; distant
Ferngeschoss(FGesch)	Long-range projectile
Ferngeschütz; Fernkampfgeschütz(FKG)	Long-range gun
Ferngesteuertes Geschoss	Guided missile
Fernladung	Long-range propellent charge
Fernrohr	Telescope
Fernsehen(Fseh)	Television
Fernsprecher(Fsp)	Telephone
Fernsteuer Gerät	Remote control guidance for winged missiles, such as V-1
Fernsteuerung	Remote control; guidance
Fertigung	Making ready; manufacture
Fertigungsjahr	Year of manufacture
Fertigzünder	Ready-fixed fuze
Fesselballon(FessB)	Captive balloon; sausage balloon
fest eingebautes Maschinengewehr	Fixed machine gun
Festigkeit	Strength; resistance; solidity
Festlegepunkt	Reference point
feststellen	to establish; ascertain; fix
Festung(Fest)	Fortress; fort
Festungsartillerie	Fortress artillery
Festungsflak(FF)	Fortress AA gun
Festungsgeschütz	Fortress gun
Festungsgraben	Moat
Festungskrieg	Siege warfare
fett	fatty; oily
feucht	moist; humid
Feuchter	Humidifier
Feuchtigkeitsgehalt	Moisture content
Feuer	Fire
Feuerbereich	Fire zone; range
feuerbeständig	fireproof
Feuerdämpfer; Flammendämpfer; Mündungsfeuerdämpfer	Flash hider; flash damper
feuerfest; feuersicher	fireproof
feuergefährlich	inflammable; liable to catch fire
Feuergewicht	Weight of gun in action
Feuerhöhe	Height of muzzle
Feuriger Schwaden	Firedamp(coal mine)
Feuerkraft	Firepower
Feuerkunst; Feuerwerk; Feuerwerkerei; Pyrotechnik	Pyrotechnics; fireworks; pyrotechny
Feuerleitgerät	Fire control instrument
Feuerleitung	Fire control
Feuerlöscher	Fire extinguisher
Feuerlöschmittel	Fire extinguishing substance
Feuerrohr	Firearm; fire tube; flue
Feuerschiff	Lightship
feuersicher	See feuerfest
Feuerstoss	Burst
Feuerstrahl; Flammenstrahl	Jet of liquid fire
Feuerverteilung(Fvtg)	Fire distribution(Arty)
Feuerwaffe	Firearm; gun
Feuerwehr	Fire department
Feuerwerk; Feuerwerkerei	See Feuerkunst
Feuerwerker	Ordnance noncommissioned officer; pyrotechnist

Feuerwerkskörper	Pyrotechnic composition
Filterbüchse	Gas mask
Filz	Felt
Filzpropfen	Felt wad
Fla(Flugabwehr)	Antiaircraft
Flachbahn	Flat trajectory
Fläche	Surface; flatness
Flachfeuer	Flat trajectory fire
Flachfeuergeschütz	Flat trajectory gun
Flachkopfgeschoss	Flat-nosed bullet
flackern	to flare; flicker
Fladdermine	Contact land mine
Flaggschiff	Flagship
Flak(Flugabwehrkanone)	AA cannon
Flakmaschinengewehr	AA machine gun
Flakpanzer	Special armored vehicle with full armor cover; used as AA weapon(See also under Panzer)
Flakvierling	Four-barreled AA gun
Flammendämpfer	See Feuerdämpfer
Flammenstrahl	See Feuerstrahl
Flammenwerfer(FmW)	Flame-thrower(See also Nebwerfer and Weitwerfer)
Flammenwerferpanzerwagen	Flame-throwing tank
Flansch	Flange
Flanschgeschoss	Flange projectile(See description)
Flascheneismine(FlEsMi)	Bottle-shaped mine placed under ice
Flam(Flammenwerfertank)	Flame-thrower tank
Flattermine	Tumbling mine
Fla-Waffe	AA weapon
Flieger	Pilot in Air Corps personnel
Fliegerabwehr	AA defense
Fliegerbombe	Airplane bomb
Fliegerdrehstütze(FlDSt)	Meaning unknown to us
Fliegerleitpanzer	Armored observation car used with front line support aircraft(See also under Panzer)
Fliegerleuchtpistole	Aircraft signal pistol
Fliehbacke	Centrifugal arming device(Fz)
Fliehbackenfeder	Spring of centrifugal arming device (Fz)
Fliehbolzen	Centrifugal safety pin(Fz); disappearing firing pin
Fliehkraft	Centrifugal force
Fliessdeckel(Dichtungsdeckel)	A cardboard disk impregnated with ozokerite, placed between propellant and shell to prevent the escape of gases (obturation) and to lubricate the gun barrel. The device was used during WW I by the Austrians.
Flinte	Shotgun
Flotte	Fleet; Navy; dye liquor
Flug	Flight; flying
Flugabwehr(Fla)	AA defense
Flugabwehrkanone(Flak)	AA gun
Flugbahn	Trajectory
Flugblatt	Propaganda leaflet
Flügel(Fl)	Stabilizing vane or fin; wing
Flügeldüse(FlDü)	Jet motor mounted on a wing
Flügelgranate	Fin-stabilized shell
Flügelmine	Fin-stabilized mortar shell

flügelstabilisiertes Geschoss	Fin-stabilized projectile
Flugzeit	Time of flight
Flugzeitmesser	Chronograph(Le Boulengé, etc)
Flugzeug(Flzg); Luftfahrzeug	Airplane; aircraft
Flugzeugabwehrkanone	See Flugabwehrkanone(Flak)
Flugzeuggeschütz; Flugzeugkanone	Aircraft (AC)gun
Fluss	River
flüssige Luft	Liquid air
Flüssigkeitsbremse	Hydraulic brake
Flüssigkeitsrücklaufbremse	Hydraulic recoil brake
Flüssigkeitszünder	Liquid escape fuze; hydraulic fuze
Flüssigluft Sprengstoff	Liquid air explosive
Flusskabel	Marine cable; underwater cable
Flusstreibmine(FlTrMi)	Drifting mine
Föhn Gerät	73 mm Rocket Launcher(See under Weapons)
Formänderung	Deformation
Formbarkeit	Plasticity
Fortbewegung	Propulsion; movement
Fortpflanzungsgeschwindigkeit	Velocity of propagation; — of transmission; or — of detonation
Fracht	Freight
Fräser	Milling; cutter; reamer
Freischärler; Partisane	See Guerillakämpfer
Frettage	Hooping; shrinkage
Frierpunkt	Freezing point
Friktionsmesser	Apparatus for measuring friction
Friktionszündschraube	Friction igniter; friction priming screw
Frittung	Fritting; sintering
Fritz	Nickname for 1400 kg AP Bomb, called in Ger "1400 kg SD" (TM9-1985-2, p 25)
Frühzerspringer	Premature burst(Arty)
Frühzündung	Premature ignition; pre-ignition(MG)
F-Stoff	Titanium tetrachloride(smoke agent) (CWS)
Fugasse	Fougasse(See general section)
Führungsband; Führungsring	Rotating band; driving band
Führungswulst	Bourrelet(See also Zentrierwulst)
Fülloch	Filling hole(Ref 6, p 57)
Füllmaterial; Füllmittel	Filling material; loading material
Füllöffnung	Charging hole (Arty)
Füllpulver(Fp)	HE filler(lit Filling powder)
Füllstelle	Installation for filling projectiles
Füllstoff	See Füllmaterial
Fülltrichter	Filling funnel
Füllung	Filling; filler
Fundamentplatte	Base-plate; foundation-plate
Funk(Fu); Funkgerät	Radio
Funke; Funken	Spark; sparkle
Funkenchronograph	Spark chronograph
Funkenzündung	High-tension priming; spark priming
Funker	Radio operator
Funklenkpanzer	Radio controlled light tank for special purposes(See also under Panzer)
Funkmessgerät(FuMG)	Radar
Funkpanzer	Armored vehicle for troop communication(See also under Panzer)
Funksendung	Radio transmission
Funkstelle(FuSt)	Radio station
Funktrupp(FuTr)	Signal corps detachment

Funkturm(FuTu)	Radio tower
Funktionsprobe	Functioning test
Funkwelle	Radio wave
Furier	Quartermaster sergeant
Füsilier	Rifleman; infantry private
Fussmörser	Plate-base mortar
Fussplatte	Foot plate; float(AA G)
Futter	Forage; fodder; lining
Futteral	Case; scabbard; sheath
Futterlauf	Liner(of a gun)
Futterrohr	Lining tube; inner liner(G)
Futterstück	Bushing(breechblock)

G

Gabel	Bracket; fork
Gabellafette	Gun carriage with shafts
Gabelstütze	Bipod
Gallert	Jelly; gelatin; glue
Gamma(Mörser)	420 mm Howitzer(See under Weapons)
Gang	Motion; action; passage(Mining)
Gangspill	Capstan
Garbe	Cone of dispersion(Guny)
Gasabwehr	Gas defence
Gasbombe	Gas bomb
Gasbrisanzgeschoss; Gasbrisanzgranate	High explosive chemical shell
Gasdruck	Gas pressure; blowback
Gasdruckbombe	Pressure bomb
Gasdruckgerät; Gasdruckmesser	Pressure gage; crusher gage (See also Messei)
Gasdruckhülse(GDrH)	High-pressure cartridge
Gasdrucklader; Gaskolbenlader	Blowback-operated(automatic) weapon; gas operated gun
Gas-Erdmine	Chemical land mine
Gasgeschoss	Chemical projectile; gas shell
Gasgewehrgranate	Chemical rifle grenade
Gasgranate(Ggr)	Chemical shell
Gashandwerfer	Chemical hand grenade
Gaskampf; Gaskrieg	Chemical warfare
Gasmörser	Chemical mortar
Gasmunition	Chemical munitions
Gasteer	Gas-tar
Gaswerfer	Chemical(gas)projector
geballte Ladung(GebLdg)	Concentrated charge(consisting of several explosive blocks tied together)
geballte Ladung 3 kg	Demolition block containing 3 kg TNT
geballte Ladung 10 kg	Demolition block containing 10 kg HE
Gebirgsartillerie(GebA)	Mountain artillery
Gebirgsgeschütz(GebG)	Mountain piece; pack gun
Gebirgsgranate	Shell for mountain guns
Gebirgshaubitze(GebH)	Mountain howitzer
Gebirgsinfanteriegeschütz	Mountain infantry howitzer
Gebirgsjäger	Mountain infantryman(See also Jäger)
Gebirgsjäger-Bataillon	Mountain infantry battalion (shock troops)
Gebrauch	Use; custom
Gebrauchsladung	Normal charge; service charge(Ammo)

Gefäss	Vessel; receptacle
Gefecht	Fight; fighting; battle (See also Kampf and Krieg)
Gefechtskopf	Warhead(Td)
Gefreiter	Private first class
Gefrierpunkt	Freezing point
Gefüge	Structure; texture
Gehalt	Content; concentration(CWS)
gehärteter Stahl	Hardened steel
gehärtet(h; H)	hardened
Gehäuse	Case; casing; housing
Geheime Staatspolizei (Gestapo)	Secret State Police
gekrümmte Flugbahn	Curved trajectory
geladen(gel)	loaded; armed; charged
Gelände	Terrain; ground; country
Gelatinedynamit	Gelatin dynamite
Gelbkreuz	Yellow cross (Ger marking for vesicants) (CWS)
Gelbkreuzgeschoss	Chemical projectile with vesicant filler
Gelbkreuzgas	Mustard gas
Gelenk	Joint; knuckle; flexible coupling
Gelenklafette	Nonrigid gun carriage
geliefert(gel)	manufactured; provided
Gemeinde Polizei	Local police; township police
Gemenge; Gemisch	Mixture
Gendarm	Rural policeman
Generalstab des Heeres (GenStbdH)	General Staff of the Army
Gepäck	Baggage; luggage
gepanzert	armored
gepanzerte Kampffahrzeuge	Armored fighting vehicles
Gerät	Nonexpendable supplies; materiel; ordnance; apparatus; instrument
Gerblohe	Tanbark; tan liquor
Gerbstoff	Tannin
gerieselt; gerillt	grooved(rifling)
gerilltes Geschoss	Cannelured bullet
gesamt	total; entire
Gesamtlänge	Over-all length
Geschoss(Gesch; Gs)	Projectile; missile
Geschossbahn	Trajectory; ballistic curve
Geschossboden	Base of projectile
Geschossdrall; Geschossdrehung	Spin of projectile
Geschossdurchmesser	Diameter of projectile
Geschossfabrik(Gf)	Projectile factory; shell factory
Geschossführung	Seating(forcing)of projectile
Geschossgewicht(Gg)	Weight of projectile
Geschossgeschwindigkeit	Velocity of projectile
Geschosshöhlung	Shell cavity
Geschosshülle	Body of projectile; shell
Geschosshülse	Cartridge case
Geschosskappe	Cap of projectile
Geschosskern	Core of bullet
Geschosskopf	Head(point)of projectile
Geschossmantel	Jacket of bullet
Geschossmine(GM)	Improvised A/T mine made of a HE shell
Geschoss-spitze; Bogenspitze	Ogive(Proj)
Geschoss-sprengstoff	Bursting charge of projectile
Geschossteile	Projectile components; bullet components
Geschosszapfen	Rear part of a shell
geschrumpftes Rohr	Built-up barrel (lit Shrunk barrel)
Geschütz	Artillery piece; gun; cannon
Geschütz auf Selbstfahrlafette	Self-propelled gun
Geschützladung	Gun propelling charge
Geschützpulver	Gun propellant
Geschützrohr	Gun barrel(See also Rohr)
Geschützverschluss	Breech mechanism; breechblock
Geschwindigkeit	Velocity; speed
Gesellschaft	Society; company
Gestalt	Form; shape; figure
Gestapo	See under German Abbreviations
Gestein	Rock; stone
Gesteinsprengmittel; Gesteinsprengstoff	Rock-blasting explosive; blasting explosive
gesteuert	controlled; steered; synchronized
gesteuertes Geschoss	Guided missile
gesteuertes Maschinengewehr	Synchronized MG
gestreckte Flugbahn	Flat trajectory
gestreckte Ladung	Bangalore torpedo (See also Rohrladung)
gestrecktes Eisen	Wrought iron (See also strecken)
Getreidemehl	Cereal meal; grain flour
getrennte Munition	Separate-loaded ammunition
Getriebe	See Wechselgetriebe
Gewalt	Power; force; violence
gewalzter Stahl	Rolled steel
Gewebe	Fabric; tissue
Gewehr(Gew)	Rifle
Gewehrblendgranate 42	See Gewehrnebelgranate 42
Gewehrgeschoss(GewG)	Rifle bullet
Gewehrgranate(GewGr)	Rifle grenade
Gewehrkartusche	Propelling cartridge for rifle grenade
Gewehrmunition	Rifle ammunition
Gewehrnebelgranate 42	Smoke grenade for rifle 42
Gewehrpanzergranate(GewPzgr)	Armor-piercing rifle grenade
Gewehrpatrone(GewPatr)	Rifle cartridge
Gewehrpulver(GewP)	Rifle propellant
Gewehrschuss	Rifle shot
Gewehrschütze	Rifleman
Gewehrsprenggranate(GewSprgr)	HE rifle grenade
gewerbliche Sprengstoffe	Industrial(commercial) explosives
Gewicht	Weight; gravity
Gewichtsladung(Gldg)	Weight of live projectile
Gewinde	Thread (of a screw); winding
gewölbt	convex; arched; vaulted
gezogen(gez)	rifled(barrel); drawn; towed
gezogener Teil des Laufes	Rifled part of barrel
gezogenes Geschütz	Rifled gun
gezogenes Ziel	Towed target
Gichtstaub	Blast furnace dust; flue dust
gieren	to yaw (See also Seitwärtsbewegung)
giessen	to pour; cast; mold
Giftnebel; Giftrauch	Toxic smoke; irritant smoke(CWS)
Giftstoff	Poisonous matter; toxic agent(CWS)

Gipfelhöhe	Maximum ordinate(Traj)
Gipfelpunkt	Summit(Traj)
Gitter	Grating; screen; grid; lattice
Glasmine	Glass land mine
Glätten(des Pulvers)	Glazing(of powders or propellants)
glattes Geschütz(glG)	Smooth-bore gun
glattes(poliertes)Pulver	Glazed(polished)powder or propellant
glattes Rohr	Smooth-barrel
glattwandig	Smooth-bore
Gleichgewicht	Balance; equilibrium
Gleis	Rail; track(RR)
Gleitbombe	Glide bomb
Glimmer	Mica
Glimmspur(Gl'spur)	Tracer with glowing composition; dim tracer
glühen	to glow
Glühdraht; Glühfaden	Filament
Glühkathodenröhre	Vacuum tube(Rad)
Glühköpfchen	Hot-wire bridge-head (in an electric igniting device)
Glühlampe	Incandescent lamp
Glühzündapparat (See also Zündmaschine)	Low tension blasting machine; exploder(Engr); electrical ignition apparatus
Glühzünder(Gluhz)	Low tension electric igniter or detonator
Glühzündkette	Electric detonator chain with delays
Glühzündstück	Low tension electric igniter or detonator
Goliath SdKfz 302 (Goliath Sprengdienst Kraftzug 302)	"Goliath" Demolition Vehicle 302
Gondel	Gondola; nacelle
Goudron	Soft asphalt or mixture of hard asphalt with high-boiling mineral oil
Graben	Trench; ditch
Grabengeschütz	Trench piece(Arty); trench gun
Grabenhaubitze	Trench howitzer
Grabenkrieg	Trench warfare
Grabenmine; Grabenmörsergranate	Trench mortar shell
Grabenmörser	Trench mortar
Grad	Degree; grade; rank
Granatbüchse(GrB)	Grenade launching rifle
Granate	Shell; projectile; grenade
Granate Beton(GrBe)	Anticoncrete shell
Granatfüllung(Grf)	Shell filler
Granatfüllung 02 (Grf 02)	Shell filler type 1902(TNT)
Granatfüllung 88 (Grf 88)	Shell filler type 1888(Picric acid)
Granathülse	Shell case
Granatkartätsche	Canister shell
Granatloch	Shell hole
Granatsignal	Projector signal; rocket signal; star shell
Granatsplitter	Shell splinter
Granattrichter	Shell crater
Granatwerfer(GrW)(See also Mörser)	Grenade thrower or projector; trench mortar; A/T grenade rifle
Granatwerfer Fünfling(GrW 5ling)	Five-barreled automatic mortar (launcher)
Granatwerfergeschoss (GrWG)	Mortar shell
Granatzünder(GrZ)	Fuze for HE shell
Granulierung	Granulation
graphische Schusstafel	Trajectory chart (not to be confused with US graphical firing table)
graphitieren	to graphite; coat with graphite
Grat	Edge; ridge; burr; seam; (in bore of a gun)
Grauguss(Gg)	Cast iron; gray iron casting
Grauspiessglanz	Antimony trisulfide(Sb_2S_3)
gravimetrisches Gewicht	Gravimetric density
Grenadier	Infantry rifleman; private(See also Panzergrenadier)
Grenze(Gr)	Frontier; border; boundary
Griff	Grip; handle
grobes Blättchenpulver(grBlP)	Propellant in large flakes
Grobgewicht	Gross weight
Grof(grosser Flammenwerfer)	Heavy flame thrower(on two-wheel carrier)
Grossadmiral	Admiral of the Fleet
Grösse	Quantity; magnitude; size
grosse Ladung(grLdg)	Large charge
grosse Zündladung(grZdlg)	Large igniter or primer charge
Grossfertigung	Mass production
grosskalibrig	large caliber; big bore
grösste Vo	Muzzle velocity
Grube	Mine; quarry; hole; pit; ditch
Grubengas; Grubenwetter	Firedamp(explosive mixture of methane and air); mine damp
Grundgeschütz	Base piece; directing gun
Grundladung(Grundldg)	Base charge; main charge(See also Schussladung)
Grundmine	Fixed ground mine; controlled mine(Nav)
Grünkreuz(Grkz)	Green cross (Ger marking for lung irritants)(CWS)
Gruppenfeuer	Group fire; volley fire
Gudolpulver(GuP)	Double-base propellant containing nitroguanidine(NGu)
Guerillakämpfer; Freischärler	Guerilla (See also Partisane)
Gulaschkanone	Field kitchen (slang)
Gummi	Rubber; gum
Gurt	Belt; strap; girdle; ammunition belt; feed belt
Gürtel	Belt; strap; band; girdle; zone
gurten	to load an ammunition belt
Guss	Casting
Gusseisen	Cast iron
Gussstahl	Cast steel; furnace steel
Gustav Geschütz; Dora	800 mm Gun(Sevastopol)(See under Weapons)
Güterbahnhof	Freight station(RR)
Güterwagen	Freight car(RR)
Güterzug	Freight train(RR)

H

haarartig	Hairlike; capillary
Hafen	Port; harbor

Haft	Custody; arrest; bolt; loop; confinement
Hafthohlladung(HaftHl)	Magnetic antitank hollow charge(HoC) (lit Adhering hollow charge)
Hafthohlladung 500g	Magnetic HoC of 500g RDX
Hafthohlladung 3kg	Magnetic HoC of 3kg RDX
Hahn	Hammer; cock; stopcock (lit rooster)
Hahnflinte	Hammer shotgun
Hahngewehr	Hammer rifle
hahnlos	hammerless
hahnloses Gewehr	Hammerless rifle
Haken	Hook; clasp; clamp; catch
Hakenbüchse	Arquebus
Halbautomat	Semi-automatic weapon
Halbdurchmesser	Radius; semidiameter
Halbkugel	Hemisphere
Halbpanzergranate(Halbpzgr)	SAP projectile
Hals	Neck; throat; stem(of a thermometer)
haltbar	stable; durable; lasting
Haltbarkeit; Beständigkeit	Stability(See also Lagerbeständigkeit)
Haltering(HRg)	Retaining ring
Halteschraube	Retaining screw(Fz)
Haltestift	Retaining pin
Haltezeichen	Stop signal
hämmerbar	malleable
Hammereisen	Wrought iron
Handbremse	Hand brake; emergency brake
Handfeuerwaffen	Small arms; shoulder arms(lit Hand firearms)
Handgranate(Hgr)	Handgrenade(HdGr)
Handgriff; Handhabe	Handle; grip
Handhabung	Handling; manipulation
Handhabungssichere Sprengstoffe	Explosives safe to handle
Handleuchtzeichen	Hand signal flare(ground)
Handrauchzeichen	Hand smoke signal(ground)
handtätig	hand-operated; manual
Handwaffe	Hand weapon; hand arm
Handwerfer(See also Granatwerfer)	Mortar; trench mortar (lit Hand projector)
Handwerkzeug	Hand tools
Hang	Slope; bent
Hangmine	Hanging mine
Harnstoff	Urea
Härte	Hardness; temper(of a metal)
Hartgummi	Ebonite
Hartkern	Hard core (such as of tungsten carbide)
Harz	Resin; rosin
Haube(Hb)	Ballistic cap(BC)on some larger caliber shells; false cap; windshield
Haubengranate(Hbgr)	Shell with BC (ballistic cap)
Haubengranatzünder(HbgrZ)	PD fuze for use under BC
Haubenschrapnell(Hbschr)	Shrapnel with false cap
Haubitze(H) (See also Mörser)	Howitzer (light and medium) (See also Steilfeuergeschütz)
Haubitze in Turm(HT)	Turret howitzer
Haubitzgranate(HGr; Hgr)	Howitzer shell
Haubitzringpulver(HRgP)	Propellant in rings for field howitzer
Haubitzzünder(HZ)	Howitzer shell fuze
Hauptgetriebe	Main transmission; main gear
Hauptkartusche(Hptkart)	Main propelling charge in non-fixed ammo (See also Kartusche and Teilkartusche)
Hauptladung	Main charge of propellant; base charge of blasting cap or detonator
Hauptmann(Hptm)	Captain
Hauptwache	Main guard
Hauptzündung	Main ignition lead-in(Bl)
hautätzend	vesicant(CWS)
Hautgift	Blister agent; vesicant(CWS)
Hebel	Lever
Hebelzünder	Lever type igniter (for Glass mine)
Heer(H)	Army (the Army, as distinguished from Armee, a tactical unit)
Heeresanstalt	Army establishment
Heeresartillerie	Army artillery
Heeresfahrzeug(Hf)	Army vehicle
Heeresflak(HFlak)	Army AA Arty
Heeresfunkstelle (HFu)	Army radio station
Heereshauptquartier	Army general headquarters(GHQ)
Heereslazarett	Army general hospital
Heeresmunitionslager(HML)	Army ammunition depot
Heereswaffenamt(HWA)	Army Ordnance Office (See under Vorplanung, etc)
Heereszeugamt	Army ordnance supply depot; quartermaster depot
Heizkraft	Heating power; calorific power
Heizplatte	Hot plate
Heizung	Heating; firing
Helm	Helmet
Hemd	Shirt; shell of a blast furnace
Hemmung	Jamming; stoppage
Hermann	Nickname for 1000 kg GP-HE bomb, called in Ger "1000 kg SC"
Hersteller	Manufacturer; fabricator
Herstellung	Production; manufacture
Hetzer	Baiter. Tank destroyer of Skodawerke (See under Panzer)
Hilfslafette	Improvised mount
Hilfstafel	Auxiliary table (Ball)
Hilfswaffe	Auxiliary arm
Hinterlader	Breech loader
Hitze	Heat; hotness; passion
H-Ladung; Hohlladung(Hl; HL)	Hollow charge(HoC); shaped charge
hochbrisanter Sprengstoff; Brisanzsprengstoff	High explosive(HE) (lit Highly brisant explosive)
hochempfindlich	supersensitive

hochempfindlicher Aufschlagzünder	Supersensitive percussion fuze
Höchstgasdruck	Maximum gas pressure
Höchstschussweite	Maximum range
Höcker	Hump; bump
Höckerhindernisse	Dragon Teeth (A/T obstacle)
hohl	hollow; concave
Höhle	Cave; cavern; hole; cavity
Hohlgeschoss; Hohlkopfgeschoss	Hollow head projectile
Hohlladung(Hl; HL)	Hollow charge(HoC); shaped charge

Note: During WWII the Germans used at least four types of hollow charges: Hl, Hl/A, Hl/B and Hl/C

Hohlladung 300g	300g Hollow demolition charge
Hohlladung 400g	400g Hollow demolition charge
Hohlladung 12.5 kg	12.5 kg Hollow demolition charge
Hohlladung 13.5 kg	13.5 kg Hollow demolition charge
Hohlladung 50 kg	50 kg Hollow demolition charge
Hohlringladung	Hollow, ring demolition charge
Hohlringladung 1.2 kg	1.2 kg Hollow, ring charge
Hohlringladung 3.2 kg	3.2 kg Hollow, ring charge
holländisch(h)	Dutch
Holzgeist; Holzspiritus	Wood alcohol; methanol
Holzkasten	Wooden box
Holzkohle	Charcoal
Holzmehl	Wood meal; wood flour
Holzmine	Wooden box mine
Holzpech	Wood pitch
Holzruss	Wood soot
Holzsteinkohle	Lignite
Holzstoff	Wood pulp; cellulose(from wood)
Holzstoffmasse	Wood pulp
Holzteer	Wood tar
Holzteerpech	Wood-tar-pitch
Holzzellstoff	Lignocellulose
Horchapparat; Horchgerät	Sound locator or detector
Hornisse	Hornet; Self-propelled A/T gun (See under Panzer)
Hubschrauber	Helicopter
Hülle	Cover; covering; case; sheath
Hülse	Hull; husk; cartridge case
Hülsenauszieher	Cartridge case extractor
Hülsenbezeichnung	Cartridge case identification (number)
Hülsenboden	Base of cartridge case
Hülsenhals	Neck of cartridge case
Hülsenkartusche(HülKart)	Cartridge case of rapid-fire non-fixed ammunition (as opposed to bag)
Hülsen(patrone)	Cartridge case
Hülsenrand	Cartridge case rim
Hummel	Bumblebee SP Howitzer(See under Panzer in descriptive part)
Hut	Hat; cap; cover; lid; top
Hütchen	Blasting cap; cup (cartridge)
Hütte	Hut; cottage; iron works; rolling mill; glass works
Hydrocyansäure; Hydrocyansäure	Hydrocyanic acid
hydropneumatische Lafette	Hydropneumatic gun carriage

I

Infanterie(I; J)	Infantry
Infanteriegeschütz (IGesch)	Infantry piece(G or How); close support gun
Infanteriegranate(Igr; Jgr)	Shell for infantry gun
Influenzdetonation	Sympathetic detonation
Ingenieur; Ingeniör	Engineer
Inhaltverzeichnis	Table of contents
Inhaltszettel	Content label
Initialexplosivstoff; Initialsprengstoff	Initiating explosive (such as M F, L A, L St, etc)
Initialimpuls	See Zündreiz
Initialladung	Initiating explosive charge
Initialzünder	Initiator
Innenzünder	Internal fuze
Innere Ballistik	Interior Ballistics
im Rohr gefüllte Reihenladung	Bangalore torpedo
Interessengemeinschaft(IG)	Association for Furtherance of Mutual Interest; Trust
Invarol	Cold resisting grease
Irdenware	Earthenware
Irrtum	Error; mistake
Isolator	Insulator

J

Jabo(Jagdbomber)	Fighter bomber
Jagd	Hunt; chase
Jagdpanther	Tank destroyer Jagdpanzer V (See under Panzer in descriptive part)
Jagdpanzer(JgdPz); Panzerjäger(PzJäg)	Tank destroyer or hunter (See under Panzer)
Jagdpulver	Hunting (sporting) propellant
Jagdtiger; Tiger Jäger	Tank destroyer (See under Panzer in descriptive part)
Jäger(J)	Hunter; chasseur; ranger; rifleman in Jägerdivision; private in Gebirgsjäger-Bataillon; fighter airplane; pursuit plane
Jägerbataillon	Light infantry battalion; ranger battalion; (See also Gebirgsjäger-Bataillon)
Jägerdivision	Light infantry division
Jägergeschütz(JG)	Light infantry piece (G or How)
Jägergranate(JGr)	Light infantry gun projectile
Jod	Iodine
Jodazid	Iodine azide
Jodessigester	Ethyliodoacetate(CWS)
Jodtinktur	Tincture of iodine
Jodzahl	Iodine number
justieren	to adjust; collimate (bore-sight alignment)

K

Kabel	Cable; wire
Kabine	Compartment; cockpit (See also Kajüte)
Kahn	Boat
Kai	Quay
Kajüte; Koje	Cabin (ship)
Kaliber(Kal)	Caliber; gauge
Kalilauge	Caustic potash(KOH)
Kalium(K), Kali	Potassium(K)
Kalk	Lime

Kalkmilch	Lime solution; milk of lime
Kalksalpeter	Calcium nitrate
Kaltklebekitt(Kkt)	Cold adhesive putty used for attaching demolition charges
Kaltspritzen	Cold extrusion (lit Cold-squirting)
Kaltrecken; Kaltreckung; Selbstschrumpfung	Autofrettage (a process used in manuf of gun barrels)(See in the general section)
Kamm	Crest; ridge; comb; cam
Kammer	Chamber; room
Kammerhülse(Kh)	Central tube; flash tube(Shr)
Kammerhülsenladung	Flash tube charge(Shr)
Kammerhülsenrohr	Burster tube
Kampf	Battle; combat; fight (See also Gefecht and Krieg)
Kampfgas; Kampfstoff	War gas; poison gas(CWS)
Kampfpistole(KP)	Rifled bore signal pistol; Very pistol (See also Leuchtpistole)
Kampfstoffbombe	Chemical bomb
Kampfwagen(Kpfw; Kw)	Combat vehicle; tank; armored vehicle
Kampfwagenfalle(KwF)	Tank trap
Kampfwagenkanone(KwK;Kpfw)	Tank gun
Kanone(K)	Cannon; gun; piece of ordnance
Kanonenboot	Gunboat
Kanonengranate(KGr)	Cannon shell
Kanonenrohr	Gun barrel
Kanonenschlag mit Raucherscheinung	Smoke-puff charge (simulated fire)
Kanonenschuss	Gun shot
Kanonenzünder	Fuze for a cannon shell
Kanonier*	Private(Arty); cannoneer
Kapitänleutnant	Lieutenant-Commander(Nav)
Kapitän zur See	Captain(Nav)
Kappe(Kp)	AP cap (See also Haube)
Kappengeschoss	Capped projectile
Kapsel	Capsule; priming cap; blasting cap; detonator
Karabiner(Kb; Kar)	Carbine
Karl Gerät	Heavy SP Mortars (See Thor and Karl Mortars)
Kartätsche	Canister(SL Ammo); case shot
Kartätschengranate; Schrapnell	Schrapnel(Shr)
Kartuschbeutel(Kartb)	Propellant bag
Kartuschdeckel(Kartd)	Cover for Kartusche
Kartusche(Kart)	Cartouche; container of propellant charge not used in fixed ammo
Kartusche, einfach	Bag container of propellant charge placed in Kartuschenhulse
Kartuschenhülse(Karth)	Cartridge case for Kartuschen(q v)
Kartuschenmunition(KartMun)	Ammunition using Kartuschen (Compare with Patronenmunition)
Kartuschenvorlage	Muzzle-flash reducing wad
Kasematte	Casemate
Kasemattenkanone(KK)	Casemate cannon
Kasemattenlafette(KL)	Casemate gun mount
Kaserne	Permanent barracks
Kasino	Officer's mess or club
Kask(such as Mk 50 Kask)	Target indicating flare (TM-9-1985-2, pp 71-2)
Kasten	Chest; box; case
Kastenlafette	Box, trail gun carriage
Katapult; Schleuder	Catapult
Kautschuk	Caoutchouc; rubber, before vulcanization
Kavalleriegeschütz	Cavalry gun
Kegel	Cone
Kennbuchstabe	Identification mark
Kennzeichen	Mark; sign; indication
Kennzeichnung	Code; designation
Kern	Core; nucleus
Kerngeschoss	Bullet with core
Kernladung	Base section(SL Ammo)
Kerzenstärke	Candle power
Kettenkugel	Chain shot
Kiesel	Flint; silica; silex, gravel
Kiff	Tan; tanbark
Kippzünder(KiZ)	Tilt type igniter
Kissen	Cushion; pad; pillow
Kiste	Case; chest, crate; box
Kitt	Cement; putty
Klammer	Clamp; clasp; put swivel(Rf); clip; parenthesis
Klappe	Flap; trap; lid; damper
Kleif(kleiner Flammenwerfer)	Portable flame thrower
kleine Ladung	Reduced charge
Kleinkaliberlauf	Small bore barrel(Rf); subcaliber tube(G)
Kleinkalibermunition	Subcaliber ammunition
Kleinluftschiff	Blimp
Kleister	Adhesive paste; thin paste
Klemme	Clip; clamp; terminal(Elec); binding post
klopffest	antiknock
Knall	Bang; crack; detonation; report
Knalldämpfer	Silencer(Rf or Pist); muffler
Knallgas	Oxyhydrogen gas
Knallglyzerin	Fulminating glycerin; nitroglycerin(NG)
Knallquecksilber	Mercuric fulminate(M F)
Knallsäure	Fulminic acid
Knallsilber	Silver fulminate(AgF)
Knallwelle	Shock wave
Knallzucker	Nitroglucose; nitrosaccharose
Knallzündschnur; Detonierende Zündschnur	Primacord; detonating fuse
Knetmaschine	Kneading machine; malaxator
Knick	Break (in curves); sharp bend
Knickzünder(KnZ)	Snap type igniter
Knopf	Button
Kochsalz	Kitchen-salt; common salt
Kohle	Coal; carbon
Koje	See Kajüte
Kohlengrube	Coal mine
Kohlensäure	Carbonic acid; carbon dioxide
Koks	Coke(coal)
Kolben	Flask; butt(Rf, Pist, MG, etc); piston
Kolbenpistole	Machine pistol
Kollodiumwolle	Colodion cotton; soluble NC
Königstiger	King Tiger(Tank)(See under Panzer)
konisches Rohr; Würgebohrung	Tapered-bore barrel(G); Squeeze bore barrel
Kontaktseemine	Contact sea mine
Kopf(Kpf)	Head; nose(B); point(Sh)
Kopfring	Front ring(Proj)
Kopfwelle(an der Spitze des fliegenden Geschosses)	Shock wave(at the tip of projectile)

Kopfzünder(KZ;Kpfz)	Point-detonating fuze(Proj); nose fuze(B)
Korb	Basket; crate; cluster of bombs (slang)
Kordit	Cordite
Korn	Grain; corn; front sight(Wp)
Körnchen	Granule
Kornpulver	Granulated powder
Körper	Body
Korvettenkapitän	Lieutenant commander(Nav)
Krach	Crack; crash
Krad	See Kraftrad
Kraft(pl Kräfte)	Force(s); strength(s); power(s)
Kraftfahrzeug(Kfz)	Motor vehicle
Kraftquelle	Power source
Kraftrad	Motorcycle
Kraftstoff	Fuel
Kraftübertragung	Power transmission
Kraftwagen	Motor car; automobile
Kraftwerk; Kraftzentrale	Power station
Kraftzug	Power traction (as a prime mover); truck with trailer
(mit Kraftzug)	(Tractor drawn; truck drawn)
Kraftzugartillerie	Motorized artillery
Krahn; Kran	Crane; cock; faucet
Krankenhaus; Lazarett; Spital	Hospital
Kreis	Circle; area
Kreisel	Gyroscope
Kreiselpumpe	Centrifugal pump
Kreiselrad	Turbine
Kreiselvisier	Gyro sight
Kreislauf; Kreisprozess	Cycle
krepieren	to burst; die; explode
krepitieren	to crepitate; crackle
Krepp	Crepe
Kreuz	Cross; crosspiece (of universal joint)
Kreuzer	Cruiser
Kreuzfeuer	Cross fire
Kreuzpulver(KrP)	Tubular propellant with a crosspiece inside of tube
Kreuzung	Intersection
Krieg	War (See also Gefecht and Kampf)
Kriegsausrüstung	War equipment; armament
Kriegsgerät	War materiel
Kriegsmarine	Navy(lit War Marine)
Kriegsministerium	War Department
Kriegsschiff	Warship
Kriegswerft	Navy yard
Kriminalpolizei(Kripo)	Criminal investigation police
Krummerlauf	Bent barrel(See description)
Krupp-Maus	Krupp Mouse heavy tank (See under Panzer)
Kübel	Jeep; bucket
kubisches Pulver	Cubic powder or propellant
Kugel	Bullet; sphere; shot; ball
kugelfest; kugelsicher	bulletproof
Kugelform 3 kg	Ball charge, 3 kg
Kugel K	See Kurt Apparat
Kugellager	Ball bearing
Kugelpatrone	Ball cartridge
Kugelspritze	See Maschinengewehr
Kugeltreibmine(KTrMi)	Spherical floating mine; unanchored automatic contact mine
Kühler	Radiator
Kühlmantel	Water jacket(MG)
Kulisse	Coulisse
Kupferdraht	Copper wire
Kupferkapsel	Copper case(blasting cap, etc)
Kupferpanzerstahlführungsring(KPS)	Bimetallic rotating band(steel covered with copper)
Kupferschiefer	Copper-bearing schist or shale
Kupferzylinder(des Stauchapparates)	Copper cylinder(for crusher test apparatus)
Kuppellafette	Cupola gun mount
Kupplung	Coupling; connection; clutch
Kurbel	Crank
Kurt Apparat or SB 400 Kugel K	Spherical, hydrostatically operated aircraft-laid skip bomb (TM 9-1985-2, pp 14-15)
Kurve	Curve; turn
Kurzschuss	Short(Guny); short shot
Kurzwelle	Short wave
Küstenartillerie(KstA)	Coast defense artillery; shore artillery
Küstenbatterie(KstBttr)	Coastal battery
Küstengeschütz(KstG)	Coast defense piece
Küstenhaubitze(KstH)	Coast defense howitzer
Küstenkanone(KstK)	Coast defense cannon
Küstenlafette(KstL)	Coast defense gun mount
Küstenmörser(KstMrs)	Coast defense mortar
Küstenmine(KstMi)	Coastal mine
Küstenwache	Coast guard

L

Laborant	Laboratory technician(male)
Laborantin	Laboratory technician(female)
laborieren	to labor; to work in a laboratory; to place
Lack	Lacquer; varnish
Lackmus; Lacmus	Litmus
Ladedichte; Ladungsdichte	Loading density; density of charge
laden	to load; charge
Ladeklappe	Breechblock
Ladekopf	A device for charging some electric bomb fuzes(lit Charging head)
Laderaum	See Ladungsraum
Ladestock	Rammer; ram-rod
Ladestreifen	Ammunition clip; cartridge clip(for loading magazine rifle)
Ladetrommel	Cartridge drum
Ladevorrichtung	Loading or feeding device; breech mechanism
Ladung(Ldg;Ld)	Load; charge; increment; filling
Ladungsbüchse; Ladungsgefäss; Ladungskaste	Blasting charge container; blasting charge box
Ladungsgewicht	Weight of filling
Ladungsraum; Laderaum; Pulverraum	Chamber; propellant chamber (See also Verbrennungsraum)
Ladungsverhältnis	Loading ratio (Ratio between weight of charge and total weight of projectile)
Ladungswerfer(LdgW)	Spigot mortar

Lafette(L)	Gun carriage; gun mount
Lafettentisch	Gun carriage bed
Lage	Situation; position; layer
Lager	Camp; depot; dump; bed; layer; bearing; seat
Lagerbeständigkeit	Stability in storage (See also Beständigkeit, Haltbarkeit and Stabilität)
Lagerungsprobe	Storing test
lackiert	lacquered; varnished
Lakmus; Lackmus	Litmus
Landelicht	Ground flare for aircraft landing
Landepanzer	Armored amphibious troop carrier (See also under Panzer)
Landmeile	Statute mile(1.609 km)
Landmine	Land mine
Landsturm	Territorial trained reserves

Note: According to H. A. Tisch of Picatinny Arsenal, the Imperial German Army had approximately the following classification: Active (ages 18–22), Reserve (22–28), Ersatz Reserve (28–32), Landwehr I (32–35), Landwehr II (35–38), Landsturm I (38–42) and Landsturm II (over 42). All classes were trained. If the men had not served 2 years in the active army, they had to go through 6 months of basic training.

Landswerke 60(L-60)	One of the tanks(See under Panzer)
Landungsrauchzeichen	Smoke generator for aircraft landing
Landwehr	See Note under Landsturm
Landwirtschaftlicher Schlepper(LWS)	Agricultural tractor of pre-WW II which was converted to a tank (See under Panzer)
Länge	Length; longitude
Länge der Waffe	Length of weapon
Langgeschoss; Langgranate	Elongated projectile
Langnebelkerze 42(NbKzL42)	Long smoke generator 42
Langrohrgeschütz	Long gun; long-barreled gun
langsam verbrennendes Pulver	Slow-burning propellant
Langwellen	Long waves(Rad)
Langzeitzünder	Long time fuse; delay fuse
Last	Load; burden; weight
Lastkraftwagen	Truck
Lauf	Barrel(SA); course; path (See also Rohr)
Laufbohrung	Bore(G)
Laufinneres, Laufseele	Bore(of a small arm)
Laufweite	Caliber(SA); (See also Kaliber)
Laufzeit	Running time(Fz)
Lauge	Lye; leach; (Sodium or Potassium Hydroxide)
Lautsprecher	Loud speaker
Lazarett; Krankenhaus; Spital	Hospital
Lazarettzug	Hospital train
Lebensdauer(des Geschützes)	Life (of a gun)
Lebhaftigkeit	Vivacity
Leere	Vacuum; emptiness; gage
Leergewicht	Weight empty
leicht(l; le; L)	light
Leichtgeschütz(lG; leG) leichtes Geschütz	Light weapon(such as recoilless gun)
Leichtmetall(Lm; LM)	Light metal(Aluminum)
Leim	Glue
Leinöl	Linseed oil
Leistung	Output; performance; capacity; work
Leiter	Conductor; leader; guide
Leitfähigkeit; Leitungsfähigkeit	Conductivity
Leitfeuer	Ranging rounds (used to establish the accuracy of the estimated distance from firing position to target)
Leitung	Electric cable; conduit
Lenkballon; Lenkluftschiff	Dirigible
Leopard	One of the tanks (See under Panzer)
Leopold	280 mm Railway Gun Model 5, called also Anzio Annie
Letten	Potter's clay; clay used for tamping
Leuchtbombe	Illuminating bomb; flare bomb
Leuchte	Light; lamp; illumination
Leuchtfallschirm	Parachute flare
Leuchtfallschirmgranate	Parachute flare shell
Leuchtfallschirmrakete	Parachute flare rocket
Leuchtgeschoss; Leuchtgranate	Star shell; illuminating shell
Leuchtgeschoss-Zünder(LgZ)	Fuse for star shell
Leuchtgranatwerfer	Pyrotechnic mortar (projector)
Leuchtkugel	Ground signal; Very signal light
Leuchtmittel	Pyrotechnic device
Leuchtmunition (LMun)	Pyrotechnic ammunition; flare ammunition
Leuchtpatrone(LPatr)	Signal cartridge; flare cartridge; (single star)
Leuchtpistole(LPist)	Smooth-bore pyrotechnic pistol; signal pistol (See also Kampfpistole)
Leuchtrakete	Signal rocket; flare rocket
Leuchtröhre	Fluorescent tube
Leuchtsatz	Luminous composition; flare composition; pyrotechnic composition
Leuchtspur(L'spur); Lichtspur	Tracer trajectory; light trail of tracer projectile
Leuchtspurgeschoss (L'spurG)	Projectile with tracer
Leuchtspurgranate (L'spurGr)	Tracer shell
Leuchtspurhülse (L'spurH)	Tracer element container
Leuchtspurmunition (L'spurMun)	Tracer ammunition
Leuchtspursatz	Tracer composition; tracer column
Leuchtstern	Star(illuminating signal)
Leucht- u Signal-Munition(LuSMun)	Signal pistol ammunition
Leuchtvisier	Luminous sight
Leuchtzeichen	Ground signal light
Leuchtzifferblatt	Luminous dial
Leutnant	Second lieutenant
Licht	Light; candle
Lichtmessung(LMess)	Flash ranging
Lichtspur(LSp)	See Leuchtspur
Lichtspurhülse(LSpH)	See Leuchtspurhülse
Lichtstärke	Intensity of light

lidern	to pack; seal; obturate
Liderung	Obturator(G); gas check
Lieferung	Supply; delivery ; lot
Lieferungsnummer	Delivery number
Linie, ballistische	Ballistic line; trajectory (See also Flugbahn)
links	to the left; levo
linksdrehend	levorotatory; counterclockwise
Linse	Lens
Lippe	Lip; edge; rim
Livens-Handwerfer	Livens projector(CWS)
Loch	Hole; opening
Lochgeschoss	Hollow point bullet (See also Hohlladung)
Lokomotivbahnhof	Engine yard(RR)
Lokomotivschuppen	Roundhouse(RR)
Losantin	Decontaminating agent (Ca hypochlorite preparation in powder or in tablet form) (CWS)
Losantinbrei	Ca hypochlorite slurry(CWS)
löschen	to extinguish; quench; slake(lime); discharge; unload(a ship)
Löschgerät	Fire extinguisher
Lösemittel; Lösungsmittel	Solvent
lösemittelfrei	solventless
Löslichkeit	Solubility
Lösung	Solution
Losungswort(Lsg)	Password
Lot	Sounding lead; plummet; solder
Lotmetall; Lotzinn	Solder
Lotse	Pilot(Nav)
Lupe	Magnifying glass
Luchs	Lynx; reconnaissance tank (See under Panzer)
Luftbüchse; Luftgewehr	Air gun; air rifle
luftdicht verschlossen	airtight; hermetically sealed
Luftdichte; Luftgewicht	Air density
Luftdruck	Air pressure(Mech); atmospheric pressure(Met); blast effect; effect of explosion
Luftdruckbremse	Air brake
Luftdruckmesser	Barometer
Luftdruckwirkung; Luftstoss	Blast effect
Luftfahrt	Aeronautics; aviation
Luftfahrzeug; Flugzeug	Aircraft
Luftflasche	Compressed air cylinder; oxygen flask
luftgekühlt	air-cooled
Luftkampfstoff	Volatile chemical agent(CWS)
Luftlandepanzer	Light armored vehicle used with Airborne(See also under Panzer)
Luftmine(LM)	Aerial mine
Luftpistole	Air pistol
Luftschutz(LS)	Air raid defense
Luftschutzraum(LSR)	Air raid shelter
Luftsog	Vacuum resulting from an explosion
Luftstoss; Blasen(See also Luftdruckwirkung)	Concussion of air caused by an explosion; blast effect
Luftstosswelle	Blast wave
Lufttorpedo(LT)	Aerial torpedo
Luftwaffe	German Air Forces
Luger(Parabellum)Pistole	See under Weapons
Lungenreizstoff	Lung irritant(CWS)
Lunte	Slow match; fuse lighter
Luntengewehr	Matchlock gun

M

MI(Kanone)	353 mm Howitzer(See under Weapons)
Macht	Might; power; force
Magazingewehr	Magazine rifle
Manöver(Man)	Maneuver
Manöverkartusche(ManKart)	Maneuver(blank)cartridge
Manöverpulver(ManP)	Maneuver(blank)propellant
Mantel	Mantle; envelope; overcoat; jacket(bullet, projectile, etc); sheath
Mantelgeschoss; Verbundgeschoss	Jacketed projectile(such as nickel-cased or steel coated); compound bullet
Mantelkanone	Jacketed gun
Mantelpatrone	Sheathed cartridge(coal mining)
Mantelringrohr; Mantelrohr	Built-up barrel(G); jacketed barrel(MG) (See also geschrumpftes Rohr and Ringrohr)
Mantelsprengstoff	Sheathed explosive
Marder(38 and II)	Marten. Nickname for some SP A/T guns (See under Panzer in descriptive part)
Marienbad	Water bath (laboratory); watering place
Marine	Navy(See also Kriegsmarine)
Marineflak	Naval AA gun
Marinelager(Marlag)	Prisoner-of-war camp for sailors
Marineministerium	Admiralty of the German Navy
Marinewaffenamt(MWA) Marinewaffenamt	Bureau of Naval Ordnance (Branch of Oberkommando der Kriegsmarine)
Mark	See Reichsmark(RM)
Marke	Mark; index mark; label; brand
Marlag	See Marinelager
Marmor	Marble
Maschinenflak	AA automatic weapon
Maschinengewehr(MG; MGew); Kugelspritze	Machine gun(MG)
Maschinenkanone(MK)	Automatic cannon
Maschinenkarabiner(MKb)	Automatic rifle or carbine
Maschinenpistole(MP)	Machine pistol; submachine gun
Maschinenpistole 44(MP 44)	Submachine gun(called later Sturmgewehr 44)
Maschinenschlosser; Mechaniker	Mechanic
Maschinenschreiber	Typist
Maschinenwaffe	Automatic weapon
Maskensicherung	Meaning unknown to us
massanalytisch	volumetric
Massenherstellung	Fabrication in series; mass production
Matrose	Sailor; apprentice seaman
Maus	Mouse; heavy tank developed by Porsche (See under Panzer)

Max(Bombe)	Nickname for 2500 kg GP-HE bomb, called in Ger "SC 2500 Max" (TM9-1985-2, p 13)
Maximalgasdruck	Maximum gas pressure
mechanischer Zünder	Mechanical fuze
Meerküste	Seacoast
Mehl	Meal; flour; dust; powder
Mehlpulver	Finely ground black powder; meal powder
Mehrfachzünder	Combination fuze
Mehrlader; Mehrladegewehr	Magazine-fed rifle; repeating rifle
Meissel	Chisel
Meisselapparat; Gasdruckmesser	Crusher gage; pressure gage (See also Messei)
Meldebüchse	Message container(carrier)
Meldebüchse, Land	Land message container (with yellow smoke generator)
Meldebüchse, See	Sea message container (with yellow smoke generator)
Meldepatrone; M-Patrone	Ground signal cartridge
Meldung(See also Nachricht)	Message; report; dispatch
Messei	Pressure gage(Arty),(lit Measuring egg)
messen	to measure; survey
Messing	Brass
Messpatrone	Bore gage
MG-Zwilling	Twin machine gun
Milag	See Militärlager
Milchglas	Frosted glass
militärische Besetzung	Military occupation
Militärlager(Milag)	Army camp
Mine	Mine; lead for pencil
Minenbombe	Aerial mine
Minenfeld; Minensperre	Mine-field
Minengang	See Minenstollen
Minengeschoss(M)	Mortar shell; high capacity, HE missile
Minenhund	Remote-controlled explosive-laden miniature tank
Minenleger	Mine layer
Minenpulver	Blasting powder
Minenräumer; Minenräumboot	Mine sweeper(Nav) (See also Räumboot)
Minenrohr; Bohrloch	Borehole
Minenschacht	Mining shaft
Minensperre	Mine field; mine obstacle
Minenstollen; Minengang	Mining gallery
Minensuchboot; Minensucher	Mine sweeper(Nav)
Minensuchgerät	Mine detector
Minentrichter	Mine crater
minenverseuchtes Gebiet	Mine-infested area
Minenwerfer(MiW)(See also Granatwerfer)	Trench mortar(lit Mine projector)
Minenwirkung	Mining effect
Minenzünder	Mine igniter
Ministerium Speer	Ministry of Armaments and War Production named after its chief, Speer
Mischmetall	Mixed metal; alloy; an alloy of cerium and lanthanum with some other rare earth metals
Mischsäure	Mixed acid(such as mixed nitric-sulfuric acid)
Mischung	Mixture; mixing; blend
Mischung Fp 60/40 mit Verzögerung(mV)	Amatol 40/60 with delay
Mitte; Mittel	Middle; mean
Mitteilung	Communication; information
Mittelkammerschrapnell	Central-burster shrapnel
mittlere Flugbahn	Mean trajectory
mittlerer Fehler	Average(mean)error
mittlerer Gasdruck	Mean pressure
Mockstahl	German steel made by direct refining of cast iron
Mollit	Centralite (See in descriptive part)
Montage	Mounting assembly
Montan-	Mountain; mining; montan; montanic
Montanwachs	Montan wax
Mörser(Mrs)	Short, large caliber howitzer; (translated also as mortar)
Mörtel	Mortar (building material)
MOTO	See under German Abbreviations
Motor	Engine
Motorrad	Motorcycle
Motorschnellboot	Motor speedboat; PT boat
Motortorpedoboot	Motor torpedo boat; PT boat
mPak	See under abbreviations
M-Patrone(MPatr)	See Meldepatrone
Muffe	Socket; coupling box; bushing; muff
Mühle	Mill
Mund	Mouth; opening; muzzle
Mundloch	Adapter opening
Mundloch(des Zünders)	Fuze hole
Mundlochbüchse	Gaine-type fuze-booster container; bushing to hold detonator in fuze
Mundlochfutter	Gaine (See general section). (lit Fuze hole casing)
Mundlochgewinde	Adapter opening thread
Mundlochschraube	Adapter plug
Mundstück	Mouth piece
Mündung	Muzzle(G); outlet; mouth(river)
Mündungsbremse	Muzzle brake
Mündungsenergie; Mündungswucht	Kinetic energy at the muzzle
Mündungsfeuer	Muzzle flash
Mündungsfeuerdämpfer	Flash damper; flash hider (See also Feuerdämpfer)
mündungsfeuerfrei	flashless(propellant)
Mündungsgeschwindigkeit	Muzzle velocity; initial velocity
Mündungskappe	Muzzle cover; tampion
Mündungsknall	Muzzle report; muzzle blast
Munition(Mu; Mun)	Ammunition(Ammo)
Munitionskasten	Ammunition box; caisson
Munitionskraftwagen(MKw)	Ammunition truck
munitionslager	Ammunition dump; ammunition depot
Munitionsloch	Ammunition pit
Munitionsträger(Mun; Muntr)	Ammunition carrier
Munitionsverpackung	Ammunition packaging

Munitionswagen	Ammunition wagon; ammunition car; caisson; ammunition carrier
M-u B-Patr	See under Ger Abbreviations
Muster	Model; type; pattern; sample
Mutter	Mother; matrix; nut; female screw
Mutterrohr	Gun tube designed to receive a liner
Mutterschlüssel	Socket wrench
Mütze	Cap; hat

N

Nab	Hub; nave
Nachbildung	Dummy; mock up; model; copy
Nachbrenner	Hangfire
Nachfolger(Nachf)	Successor
Nachforschung	Research; investigation
Nachleuchten	Afterglow; phosphorescence
Nachricht(See also Meldung)	News; information; notice; message
nachrichten	to repoint; reaim; correct the range
Nachrichtenmittel	Means of intercommunication
Nachrosten	Corrosion; after-rusting
Nachzündung	Retarded ignition
Nadel	Needle; firing pin(Fz)
Nagel	Nail
Nahkampfgeschütz	Close-range gun
Nahkampfmittel	Close combat material(weapon)
Nahpatrone	Low velocity cartridge used for close combat; close-range round; silencer cartridge (SA)
Nahwerfer	Short range flame thrower (See also Flammenwerfer)
Näpfchen	Cup; small dish or bowl; blank (for blasting caps)
Nase	Nose; cap; stud; lug
Nasenrachenreizstoff	Sternutator; nose and throat irritant(CWS)
Nashorn	Rhinoceros; SP A/T Gun (See under Panzer in descriptive part)
nass	wet; moist
Nassbrandpulver	Black powder contg 72-75% of K nitrate (See also Schwarzpulver)
Nässegehalt; Nassgehalt	Moisture content
Natrium	Sodium
Natriumnitrat; Natronsalpeter	Sodium nitrate; chile saltpeter
Nebel(Nb)	Smoke(CWS); fog; mist
Nebelbombe(NbB)	Smoke bomb
Nebeldecke; Nebelwand	Smoke screen; smoke blanket
Nebelgeräte	Smoke producing equipment
Nebelgeschoss(NbG)	Smoke projectile
Nebelgranate(NbGr)	Smoke shell
Nebelhandgranate(NbHgr)	Smoke hand grenade
Nebelkasten	Smoke generator
Nebelkerze(NbK)	Smoke candle; thermal smoke generator
Nebelkerzen Wurfladung (NbKerzWfldg)	Propelling charge for thermal smoke grenade
Nebelpatrone(NbPatr)	Smoke cartridge
Nebelstoff	Smoke agent; screening agent(CWS)
Nebeltopf	Smoke pot(CWS)
Nebeltrommel	Drum-type smoke container
Nebelwerfer(NbW)(See also Raketenwerfer and Wurfgerät)	Rocket launcher (lit chemical smoke projector)
Nebelwerfer 41	A six-tube rocket launcher (See descriptive section)
Nebelwurfgranate(NbWgr)	Mortar smoke-shell
Nebelzerstäuber	Smoke sprayer
Nebenprodukt	By-product
Nebenschluss	Shunt
Nest	Nest; pocket(in ore); position consisting of a group of foxholes with shallow connecting trenches
netto	net
Nettogewicht	Net weight
Netz	Net; netting; gauze; grid; wiring system
Neuseelen	Relining; retubing(G)
Neusilber	German silver; nickel silver
nichtbrisanter Sprengstoff	Low explosive (lit Nonbrisant explosive)
nichtrostender Stahl	Stainless steel (lit Rustless steel)
Niederdruck	Low pressure
niederländisch	See holländisch
Niederschlag	Precipitate; sediment
Niet; Niete	Rivet; pin
Nitratpulver	Nitrate powder
Nitrierbaumwolle	Nitrating cotton
Nitriergemisch	Nitrating mixture
Nitrierung; Nitration	Nitration; nitrating
Nitrocellulose; Nitrozellulose	Nitrocellulose(NC)
Nitroglycerin(Ngl); Nitroglyzerin	Nitroglycerin(NG)
Nitroglykol	Nitroglycol(NGc)
Nitroguanidin(Nigu)	Nitroguanidine(NGu)
Nitropenta(Np); Pentrit	Pentaerythritol tetranitrate(PETN)
Nitropentapulver	Propellant containing PETN
Nitrostärke	Nitrostarch
Nitroverbindung	Nitro compound
Norm	Standard
normieren	to standardize; gage; regulate
norwegisch(n)	Norwegian
Notbremse	Emergency brake
Notfeuer	See Sperrfeuer
Notlandung	Emergency landing
Notsignal	Distress signal; SOS
Notsignalfakel	Distress signal flare(torch)
Nudelpulver (NdP; NP)	Chopped cord propellant; nodular(noodle)propellant
Nummer(Nr)	Number
Nuss	Nut; tumbler
Nut; Nute	Groove ; slot
Nutsche	Nutsch; suction filter
Nutzarbeit	Usefule work
Nutzeffekt; Nutzwirkung	Efficiency; useful effect
Nutzfahrzeug	Commercial vehicle
Nutzkraftwagen	Commercial motor vehicle
Nutzlast	Useful load; pay load
Nutzleistung	Net horsepower

O and Ö

Ober-	Upper; chief; supreme; superior
Oberbefehlshaber, Oberster Befehlshaber	Commander-in-Chief
Oberdecke	Housing cap
Oberfeldkommandantur	High Field Command
Oberfeldwebel (See also Oberwachtmeister)	Master sergeant (except in Arty & Cavy)
Oberfeuerwerker	Master sergeant (Ord)
Oberfläche	Surface; area
Obergefreiter	Corporal
Obergrenadier	Private 1st Class(Infy)
Oberjäger	Private 1st Class(Mountain Infy)
Oberkanonier	Private 1st Class (Arty)
Oberkommando des Heeres(OKH)	Army High Command
Oberkommando der Kriegsmarine(OKM)	High Command of the Navy
Oberkommando der Luftwaffe(OKL)	High Command of the Air Force
Oberkommando der Wehrmacht(OKW)	High Command of the Armed Forces
Oberleutnant	First lieutenant
Oberpanzergrenadier	Private 1st class in armored infantry
Oberpionier	Private 1st class in engineers
Oberquartiermeister	Deputy Chief of the General Staff
Oberreiter	Private 1st class(Cavy)
Oberschütze	Private 1st class(Infy rifleman)
Oberst(O)	Colonel
Oberster Befehlshaber der Wehrmacht	Commander-in-Chief of the Armed Forces
Oberstleutnant	Lieutenant colonel
Oberwachtmeister (See also Oberfeldwebel)	Master sergeant(Arty and Cavy)
Oel	See Öl
Ofenrohr	Stovepipe(slang term for 88 mm Rocket Launcher described under Weapons)
Offizier	Officer
Öfnung	Opening; orifice
ohne Verzögerung(oV)	without delay (Fz)
Öl; Oel	Oil
Ölbombe	Oil bomb
Öldruckbremse	Hydraulic brake
Oppanol	Polyisobutylene(synthetic substance resistant to mustard gas and Lewisite) (CWS)
O-Punkt; Nullpunkt	Aiming point(Guny)
Order	Order; medal; decoration
Orgelgeschütz	Organ gun; multiple barrel gun
Ort	Locality; place(See also Standort)
ortsfest	fixed; permanent; in fixed emplacement
ortsfeste Flak	Fixed AAG; fixed AA Arty
ortsfeste Lafette	Stationary gun mount
Ortungsleuchtzeichen	Ground position signal; signal bomb illuminating ground
Ostwind	Eastwind; SP AA gun (See under Panzer in descriptive part)
Otter	Paravane

P

Pack; Paket	Pack; bale; bundle; parcel
Packhaus; Packhof	Warehouse; shipping department
Packstoff	Packing material; packing
Pak	See Panzerabwehrkanone
Pak-Flak	A/T-AA gun; dual-purpose gun
Pakgeschütz	A/T gun
Pakgeschütz auf Selbstfahrlafette	Self-propelled A/T gun; tank destroyer
Panther	Same as Panzerkampfwagen V (See under Panzer in descriptive part)
Pantiger	Tiger II or King Tiger(See under Panzer)
Panzer(Pz)	Armor; cuirasse; tank(See descriptive section)
Panzerabteilung	Tank detachment
Panzerabwehr	A/T defense
Panzerabwehrgewehr, later called Panzerbüchse	A/T rifle
Panzerabwehrgeschütz	A/T gun
Panzerabwehrkanone (Pak), later called Panzerjägerkanone	A/T gun
Panzerabwehrmine	A/T mine
Panzerabwehrrakete	A/T rocket
Panzerartillerie	Armored artillery
Panzerbefehlswagen (PzBefWg)	Tank with a minimum of armor and arms; equipped with radio for command use (See also under Panzer)
Panzerbeobachtungswagen	Armored car used for artillery spotting(See also under Panzer)
Panzerblech; Panzerplatte	Armor plate
Panzerbombe	A/T bomb; AP bomb; heavy-case bomb
panzerbrechend; panzerdurchschlagend	armor-piercing
Panzerbüchse, formerly called Panzerabwehrgewehr	A/T rifle
Panzerdurchschlagleistung	Penetration; armor-piercing capacity
Panzerfahrzeug	Armored vehicle; tank
Panzerfahrzeugfalle; Panzerfalle	Tank trap
Panzerfahrzeuggraben	A/T ditch
Panzerfaust(PzF)	Armor Fist (See under 44.5 mm Weapons and under Faustpatrone)
Panzerfaust 30	Formerly Faustpatrone 2
Panzerfaust 30(klein)	Formerly Faustpatrone 1
Panzergeschoss(PzG)	AP projectile
panzergeschützt	armor-protected
Panzerglas	Multiple laminated glass, resisting bullet penetration

Panzergraben	A/T ditch
Panzergranate(PzGr; Pzgr)	A/T(AP) projectile
Panzergranate 39 (Pzgr 39)	APCBCHE(armor-piercing capped, ballistic cap, high-explosive) projectile, type 39
Panzergranate 40(Pzgr 40)	AP projectile with a tungsten carbide core, type 40
Panzergranate 41(Pzgr 41)	AP projectile with a tungsten carbide core for tapered bore gun (type 41)
Panzergranate-Patrone	AP fixed round of ammunition
Panzergrenadier	Private in armored infantry brigade
Panzergrenadier-Division	Motorized division (See also SS-Panzer-grenadier-Division)
Panzerhandmine 3kg(PHM 3)	Magnetic A/T hollow charge 3 kg hand mine
Panzerjäger	Tank destroyer(See also Jagdpanzer)
Panzerjägerabteilung	Tank destroyer detachment
Panzerjägergeschütz; Panzerjägerkanone	A/T gun(See also Panzerabwehrkanone)
Panzerkampfwagen(PzKpfw) (See also under Panzer in the descriptive section)	Full-track tank with tactical armor and weapons, used in organized front line units; armored combat vehicle
Panzerkampfwagen I (PzKpfw I); Panzerkampfwagen II (PzKpfw II); Panzerkampfwagen III (PzKpfw III); Panzerkampfwagen IV (PzKpfw IV); Panzerkampfwagen V (PzKpfw V); Panzerkampfwagen VI (PzKpfw VI)	See under Panzer in descriptive part
Panzerkanone (PzK); Kampfwagenkanone (KwK)	Tank gun
Panzerkopf(Pzk)	AP cap; piercing cap; armored head
Panzerkorps	Armored corps
Panzerkraftfahrzeug; Panzerkraftwagen	Armored vehicle; armored car
Panzerlafette	Armored mount; armored carriage
Panzerleuchtspurgeschoss (PzL'spurG)	AP-T shot
Panzermine; Panzerwagenmine	A/T mine
Panzermine 43(PzMi 43)	Magnetic A/T mine 43
Panzermunition	AP ammunition; tank ammunition
Panzerpatrone	Complete round AP shot
Panzerplatte	See Panzerblech
Panzerschild	Armor-plate shield
Panzerschreck	Armor Terror(88 mm Rocket Launcher) (See under Weapons)
Panzerschütze	Tank gunner
Panzerselbstfahrlafette (PzSfe)	Armored SP gun mount
Panzerspähwagen(PzSpW)	Rapid, lightly armored vehicle for reconnaissance (See also Aufklärungspanzer and under Panzer)
Panzersprenggeschoss (PzsprG)	HEAT projectile; HE A/T projectile
Panzersprenggranate(PzsprGr)	HEAT shell; HE A/T shell
Panzerstahl	Armor steel
Panzerstärke	Thickness of armor
Panzerturm	Turret of a tank (lit Armored turret)
Panzerung	Armor; armor plating
Panzerwaffe	Armored weapon
Panzerwagen	Armored combat vehicle
Panzerwagenmine	A/T mine
Panzerwurfmine	A/T [illegible] mortar shell or bomb; A/T hand grenade
Panzerzug	Armored train(RR); tank platoon
Papiermasse	Paper pulp; papier-mâché
Pappe; Pappdeckel	Cardboard; paperboard
Papphülse(für Wurfgranate)	Cardboard cartridge for mortar shell
Pappmine	Cardboard mine
Pappminenzünder	Igniter for cardboard mine
Parabellum(Luger) Pistole	See under Weapons
Parade Marsch	Goose step
Parole	Password
Partisane	See Guerillakämpfer
Patrone(Patr) (Compare with Kartusche)	Cartridge(SA); round of QF fixed ammo (Arty)
Patrone 318(Patr 318)	Fixed AP ammo used in A/T rifle 39(PzB 39); (the bullet usually contained a small charge of lacrymatory gas)
Patronenauswerfer	Cartridge ejector
Patronenauszieher	Cartridge extractor
Patronenbeutel	Pouch; cartridge belt
Patronenfabrik	Cartridge factory; ammunition plant
Patronenfüllmaschine	Cartridge loading machine
Patronengurt; Patronengürtel	Cartridge belt
Patronenhaken	Shell extractor
Patronenhals	Collar of the cartridge
Patronenhülse(PatrH)	Cartridge case of fixed ammo
Patronenkasten(PatrKast)	Cartridge box; ammunition box
Patronenlager; Patronenkammer	Cartridge chamber
Patronenmunition(PatrMu)	Fixed ammunition (Compare with the Kartuschenmunition)
Patronenrahmen	Clip(Rf and AA gun)
Patronenrand	Rim of a cartridge case
Patronenraum	Propelling charge chamber in mortar shell
Patronenstreifen	Cartridge clip
Patronentrommel	Cartridge drum
Patronenzuführung	Cartridge feed mechanism (SA)

Pauspapier	Tracing paper
Pech	Pitch; asphalt; cobbler's wax
Peilung	Direction finding; bearing
Pendelapparat	Pendulum apparatus
Pendeln des Geschosses	Oscillation (precession) of a projectile
Pendelung	Oscillating motion (See also Seitwärtsbewegung)
Pentrit	See Nitropenta
Perkussionszünder	Percussion igniter
Perkussionszündhütchen	Percussion cap
Perkussionszündung	Percussion priming or igniting
Perlitguss (PG)	Cast steel in pearlite condition
Perstoff	Diphosgene; superpalite ($ClCO_2CCl_3$)
Petarde	Closed metallic box filled with black powder (used formerly as a demolition charge)
Petrol; Petroleum	Kerosene; petroleum
Pfahl	Picket; stake; post; pile
Pfeife	Whistle; pipe
Pfeifpatrone	Whistling pyrotechnic signal cartridge used as gas alarm
Pfeifsignal	Whistle signal
Pfeil	Arrow
Pfeilgeschoss	Arrow-type, fin stabilized, discarding sabot artillery projectile
Pfennig	1/100 Reichsmark or Deutschmark
Pferdestärke (PS); Pferdekraft (PK)	Metric horsepower (1 PS = 0.986 HP)
Pferdezug	Horse draught; horse team
Pfiffikus; Phenyldichlorarsin	Phenyldichlorarsine (CWS)
Pfropfen	Wad; wadding; plug; stopper
Phosgen	Phosgene; carbonylchloride (CWS)
Phosphor	Phosphorus
Phosphorbombe; Phosphorfliegerbombe	Phosphorus bomb
Phosphorgeschoss (PrGesch)	Phosphorus (incendiary) bullet
Phosphorgeschoss mit Stahlkern	AP-inc steel core bullet with phosphorus
Phosphormunition	Phosphorus ammunition
Pi-Kampfmittel	Engineer combat equipment
Pikrinsäure	Picric acid
Pille	Pill; pellet; primer
Pillenhalter	Detonator pellet
Pilz	Mushroom; mushroom head of obturator; small pill-box
Pilzmine	Mushroom land mine
Pioniertruppe	Corps of Engineers
Pirschbüchse	Stalking rifle; hunting rifle
Pistole (Pist)	Pistol
Pistolenpulver	Pistol propellant
Platte	Plate (Tech); phonograph record
Plättchenpulver (PeP)	Disk propellant
Plattenpulver	Rolled propellant; sheet propellant
Platz	Place; square (in a city or town); space; airdrome; landing field
Platzpatrone (PlPatr)	Blank cartridge
Platzpatronengerät	Weapon for firing blank cartridges
Plombe	Lead seal
Plongierschuss	Plunging fire; mortar fire
Plotz	Explosion
pneumatisches Geschütz	Pneumatic gun
Polizist; Schutzmann	Policeman
Polklemme	Battery terminal binding post (Elec)
Potenz	Power (Math)
Prahm	Barge; lighter (Nav)
Prallschuss; Prellschuss	Ricochet
Pressling (Pr)	Pressed article; molding; briquet
Pressluft	Compressed air
Press-stoff (PrS)	Thermosetting plastic; (lit Pressed material)
Presswerkzeug	Forged tool
Pr-Geschoss	See Phosphorgeschoss
Primärladung; Aufladung	Primary charge of a cap or of a detonator
prismatisches Pulver	Prismatic propellant
Probe	Test; trial; essay; sample (See also Prufung)
Probeschiessen	Test firing
Profil	Profile; cross section; tread of a tire
profiliert	streamlined
Progressivdrall; zunehmender (wechselnder) Drall	Increasing twist of rifling; progressive rifling
Progressivpulver	Progressive burning propellant; progressive propellant
Propagandageschoss 41	Leaflet projectile 41
Propagandawerfer	Launcher for leaflet projectile
Protze (Pt)	Limber (Arty)
Prozentsatz	Percentage
Prüfgerät	Testing apparatus
Prüfung	Proof; test; testing; assay; trial; verification; examination
Prüfungsschiessen	Test firing proof firing
Puffer	Buffer; shock absorber
Pulk	Formation (Avn slang); boat-type runner placed under gun wheels for operations in deep snow
Pulver (P)	Propellant; powder
Pulverbrennzünder	Powder-train ignition fuze (See also Doppelzünder)
Pulverbrennzündung	Powder-train ignition (Fz)
Pulverbündel	Propellant bag
Pulverfabrik	Explosive plant; powder works
Pulverfüllmaschine	Apparatus for charging cartridges with powder

Pulverhaus	Propellent or powder magazine
Pulverkammer; Pulverraum	Propellent or powder chamber
Pulverkasten	Ammunition box (lit Powder box)
Pulverladung; Pulvertreibladung	Propellent (powder) charge
Pulvernäpfchen	Powder cup
Pulver ohne Lösung (POL)	Solventless propellant; powder without solvent
Pulverpresskörper	Powder compressed into large cakes
Pulverraum	See Pulverkammer
Pulverring; Pulversatzring	Powder ring (Fz)
Pulversatz	Powder train (Fz); powder pellet; powder composition
Pulversatzzeitzünder	Powder train time fuze
Pulverschlauch	Quick match
Pulversprengstoff	Low explosive
Pulverstaub	Powder dust
Pulvertreibladung	See Pulverladung
Pulverstütze	Propellent support
Punktfeuer; Punktschiessen	Point fire; converging fire
punzen	to punch; cut; carve
Püppchen	Little Doll; 88 mm Rocket Launcher (See under Weapons)
Puppe	Dummy (for bayonet, etc)
Putzstock	Cleaning rod
Putzwolle	Cotton waste (for cleaning)
Pyrotechnik (See Feuerkunst)	Pyrotechnics; pyrotechny

Q

Quadrantenvisier	Quadrant sight
Quadrat	Square
Qualm	Dense smoke
Quecksilber	Mercury; quicksilver
Quellstoff; Quellsubstanz	Substance that swells (such as NC)
Quellung	Swelling; soaking
Quellungsvermögen; Quellvermögen	Swelling power
quer	across; obliquely; transverse
Querdeckung; Querwall	Tranverse (Fort)
Querschläger	Ricochet; obliquely striking projectile
Querschnitt	Cross section
Querschnittbelastung	Cross-sectional load
Querstreuung; Breitenstreuung	Lateral dispersion; deflection dispersion (Ball)
quetschen	to crush; bruise; squeeze; pinch
Quetschhahn	Pinchcock
Quetschladung	Camouflet (See general section)
Quetschmine	Crushing mine
Quetschmühle; Quetschwerk	Crushing mill; crusher

R

Rache	Revenge; vengeance (See also Vergeltung)
Rachenreizstoff	See Nasenrachenreizstoff
Rad	Wheel; bicycle
Radachse	Axle
Räderlafette; Radlafette (RL)	Wheeled gun mount (carriage)
Radfahrabteilung	Bicycle detachment
Radiogesteuerterzünder	See Abstandzünder
Radkappe	Hub cap
Radnabe	Hub
Radreifen	Tire of a wheel
Rahmen	Frame; clip
Rahmenlader	Clip loader; magazine loader
Rakete	Rocket
Rakete mit festem Brennstoff	Rocket with solid fuel
Rakete mit flüssigem Brennstoff	Liquid-fuelled rocket
Raketenantrieb	Rocket propulsion
Rakentenapparat	Rocket launcher (See also Raketenwerfer)
Raketenbombe	Rocket bomb
Raketengeschoss	Rocket projectile
Raketenpanzerbüchse (Ofenrohr)	Antitank rocket launcher; bazooka (See under 88 mm Weapons)
Raketenstart	Rocket-assisted take-off (Avn)
Raketenstartbombe	Rocket-assisted bomb
Raketenwerfer; Raketenwurfmaschine	Rocket launcher; rocket projector
Raketenwerfer 43 (RW 43) and Raketenwerfer 54 (RW 54)	Rocket launchers 43 and 54 (See under 88 mm Weapons)
Ramme	Ram; rammer; pile driver
Rampe	Ramp; platform
Rampenmine	Ramp land mine (improvised, mine under an inclined board)
Rand	Rim; flange; edge; border
Randdüsenzünder	Rimvent fuze
randeln; rändern	to knurl; crimp; edge; rim
Randfeuerpatrone	Rim-fire cartridge
randlose Patrone	Rimless cartridge
Randpatrone	Rimmed cartridge
Randpatronenhülse	Rimmed cartridge case
Rasanz der Flugbahn	Flatness of trajectory
rascher Satz	Meal-powder composition (Pyro)
Raspel; Raspe	Rasp
Rast	Rest; notch; detent
Raster	Screen
Rasthebel	Rest lever; notch lever
Rauch	Smoke; fume; vapor
Rauchballpatrone	Smoke-puff signal cartridge
Rauchbündelpatrone	Smoke cluster cartridge; four smoke trails signal cartridge
Rauchentwickler	Smoke generator; smoke box
Rauchgranate	Smoke shell
Rauchkerze	Smoke candle (CWS)
Rauchkörper (RK)	Smoke filler (Ammo)
Rauchkörper für Schiedsrichter (RKfS)	Smoke-puff charge for use by umpire in maneuvers
rauchlos	smokeless
rauchloses Pulver	See rauchschwaches Pulver
Rauchmeldepatrone	Smoke signal cartridge for dropped messages (Avn)

Rauchnotzeichen	Smoke distress signal
Rauchpatrone (RPatr)	See Rauchsignalpatrone
Rauchrohr	Tubular smoke generator
Rauchsatz	Smoke composition; smoke signal
rauchschwaches Pulver (See also rauchloses Pulver)	Smokeless propellant (lit Propellant giving little smoke)
Rauchschwimmer	Floating smoke pot
Rauchsignalpatrone; Rauchpatrone	Smoke signal cartridge
Rauchspurgeschoss	Smoke tracer bullet
Rauchspurpatrone	Single smoke trail signal cartridge
Rauchstrichpatrone	Smoke streak signal cartridge
Rauchvorhang; Rauchschleier	Smoke curtain; smoke screen
Rauchwolke	Smoke cloud
Rauchzeichenpatrone	Smoke signal cartridge
Raum	Space; room; chamber; volume
Raumbildentfernungsmesser	Stereoscopic range finder
Räumboot (R-Boot)	Mine sweeper (See also Minenräumer)
Raumchemie	Stereochemistry
Raumdichte	Density by volume
Raumgewicht	Weight per unit volume; bulk density
Rauminhalt; Raumgehalt	Volume; cubic capacity
Räumotter	Paravane
Raupe	Caterpillar; caterpillar track
Raupenlafette	Caterpillar mounting (G)
Raupenschlepper	Caterpillar tractor
R-Boot	See Räumboot
Reagens (pl Reagenzien); Reaktionsmittel	Reagent
Rechengerät	Calculating apparatus; computer
Rechenschieber	Slide rule
Rechtsdrall	Right-handed twist of rifling
rechtsdrehend	dextrorotatory; clockwise
rechtsgängig	right-hand (threads, etc); clockwise
rechtwinklig	rectangular
Reduzierung	Reduction
Referat	Abstract; review; report
Regel	Rule; standard
Regelung	Regulation; control
Regendecke	Tarpaulin
Rehposten	Buckshot
Reibahle	Reamer
reiben	to rub; grind; triturate; rasp; grate
Reibedraht	Friction wire
Reibepulver	Abrasive powder
Reibungsbremse	Friction brake
Reibungskoeffizient	Coefficient of friction
Reibungsprobe	Friction test
Reibungszündsatz	Friction detonating train
Reibzündschraube	Friction primer (threaded)
Reichsanstalt	Government Institute
Reichsdruckerei (Rdr)	Government Printing Office
Reichsforschungsrat	State Research Council
Reichsluftfahrtministerium (RLM)	Air Force Ministry

Reichsmark (RM)	Monetary unit beofre 1947, equal to about 23 cents. Presently called Deutschmark (DM)
Reichspatent; Bundespatent	German patent
Reichweite	Range; maximum range
Reifen; Reif	Tire; ring; hoop; tire; band
Reifenpanne	Puncture; blowout; flat tire.
Reihe	File; row; series
Reihenladung	Elongated charge
in Rohr gefüllte Reihenladung	Bangalore torpedo
Reihenschaltung	Connection in series (Elec)
Reihenwurf	Train release; train bombing
rein	pure; clean
Reinheitsprobe	Test for purity
Reinigung	Purification; cleaning
Reinigungsbürste	Bore brush; cleaning brush (Ord)
Reissblei; Graphit	Graphite
Reissanzünder	Friction (pull) igniter or primer
Reissleine	Rip cord
reitende Artillerie	Horse artillery
Reiter	Rider; horseman; private (Cavy)
Reitergewicht	Rider (the weight)
reizender Kampfstoff	Irritant agent; lacrimator (CWS)
Reizgas	Irritant gas; tear gas
Reizgeschoss	Irritant gas projectile
Reizstoff	Irritant; harassing agent (CWS)
Repetierwaffe	Repeating weapon
Reserve	Reserve
Reserve I	Inactive reserve of fully trained men under 35.
Reserve II	Inactive reserve of partly trained men under 35
Reservezündung	Auxiliary ignition lead-in (blasting)
Rest	Residue; remainder; rest
Restflugweite	Remaining range; straight-line distance between point of burst and theoretical point of impact
Rettungsboje	Life buoy
Rettungsfahrzeug	Lifeboat
Revolverkanone	Revolving cannon
Revolver mit Wiederspannabzug	Double-action revolver
richten	to direct; point a gun; aim; judge
Richtfernrohr	Telescopic sight
Richtgerät	Aiming device
Richtung	Direction; pointing; laying (of a gun)
Richtungshörer	Sound locator
Richtungsschiessen	Adjustment fire for direction (See also Einschiessen)

Riefe	Groove; channel
Riefelung	Channel; groove; cannelure
Riegel	Bolt; rail; bar
Riegelblock	Breechblock
Riegelmine	See R-Mine
Riemen	Strap; sling; belt
Riffeltrichter	Ribbed funnel
Rille	Cannelure; groove; furrow
Rillenmunition; R-Munition	Rimmless cartridge case for ball SA Ammo
Ring	Ring; link; band; loop
Ringenlage	Ring layer
Ringgranate	Ring shell; shell with pre-arranged fragmentation
Ringkanone	Built-up gun; jacketed gun
Ringpulver (RgP)	Annular or ring propellant
Ringrohr	Built up barrel (G)
Ringstütze	Ring on tripod support
Rinne	Channel; groove; furrow; gutter
Rippe	Rib; cooling fin of an air-cooled engine
Rittmeister	Captain (Cavy)
R-Mine; Riegelmine	Cross bar land mine
R-Munition	See Rillenmunition
Röchlinggranate (RöGr)	See in descriptive part. under R
Roggen	Rye
Roheisen	Pig iron
Rohöl	Crude oil
Rohr (R; Ro)	Tube; pipe; gun barrel (See also Lauf and Geschützrohr)
Rohrabnutzung	Erosion of the bore (See also Ausbrennung des Rohres)
Rohrbreite	Caliber (See also Kaliber)
Rohrbremse; Rücklaufbremse	Tube brake; recoil brake (G)
Röhre (R; Ro)	Tube (radio); nozzle; spout; duct
Röhrenlafette	Tubular mount (G)
Röhrenpulver (RP)	Tubular (perforated) propellant
Rohrfrei (Rf; R frei)	Empty gun barrel
Rohrinneres; Rohrseele	Bore of a gun
Rohrkarre	Tube carriage
Rohrladung Stahl, 3kg	Bangalore torpedo, 3 kg in steel pipe (See also in Rohr gefüllte Reihenladung and gestreckte Ladung)
Rohrmantel	Gun tube jacket
Rohrmündung	Muzzle of a gun
Rohrrücklauf	Barrel recoil (G)
rohrsicherer Zünder	Bore-safe fuze
Rohrsicherheit des Zünders	Bore-safety of fuze
Rohrweite; Kaliber	Caliber
Rohrzange	Pipe wrench; Stillson wrench
Rohrzerspringer	Premature in a gun barrel
Rohstoff	Raw material
Rolle	Roller; roll
Rollenbombe	Rolling mine
Röntgenstrahlen; X-Strahlen	X-rays
Rost	Rust; grate; grill
rostfrei	noncorrosive; stainless

Rotes Kreuz	Red Cross
Rotkreuz	Red cross (for marking on time fuzes of some artillery shells not contg poison gases)
R-Patrone	Smoke-puff cartridge; flash and sound cartridge
Rückdruck	Thrust reaction pressure (Rock)
Rücklauf; Rückstoss	Recoil
Rücklaufbremse	Recoil brake (G)
Rücklaufeinrichtung	Recoil mechanism
Rücklauflos (Rf)	Recoilless
Rücklaufloses Geschütz (RfG)	Recoilless gun
Rückschlag	Blowback (Ord); back pressure
Rückstoss; Rücklauf	Recoil; kick (Ord)
Rückstossfrei (Rf)	Recoilless
Rückstossfreiekanone (RFK; RfK)	Recoilless gun
Rückstossfreierwerfer (RfW)	Recoilless launcher
Rückstosslader	Recoil-operated automatic weapon
Rückstossmotor	Jet-propulsion engine
Rührer; Rührapparat	Stirrer; agitator
Rumpf	Trunk; torso; fuselage (AC)
Rundblickfernrohr (RblF)	Panoramic telescope
Runde	Tour; round; circle; curve.
Rundfunksender	Radio broadcasting station
Rundgeschoss	Round bullet
Rundkopfgeschoss	Round nose bullet
Russ	Soot; lampblack
Rüstung	Armament; equipment
Rüstungswerk	Armament plant; war-plant
rütteln	to shake; jolt
S	
Säbel	Saber; sword
Sachindex; Sachregister	Subject index
Sack	Bag; sack; pouch
Saft	Juice; electric current
Sägemehl	Sawdust
Salmiak	Sal ammoniac; Am chloride
Salpeter	saltpeter; K nitrate; niter
Salpetergrube	Saltpeter mine
Salpeterhütte	Niter works
Salpetersäure	Nitric acid
Salpeterschwefelsäure	Mixture of nitric and sulfuric acids; mixed acid
Salpetrige Schwefelsäure	Nitrosylsulfuric acid
Salvenfeuer	Salvo (or volley) fire
Salvengeschütz	Automatic gun
Salz	Salt
Salzkartusche	Flash-reducing wad (lit Salt cartridge)
Salzsäure	Hydrochloric acid; muriatic acid
Salzvorladung; Salzvorlage	Flash-reducing wad contg some salts
Sammler (batterie)	Storage battery
Sandbad	Sand bath

Sandpapier	Sand paper
Sandprobe	Sand test; dust test
Satan (Bombe)	Nickname for 1800 kg GP-HE Bomb, called in Ger SC 1800 Satan (TM 1985-2, p 12)
Sättigung	Saturation; satisfaction
Satz	Set; composition; unit; deposit; sediment; pellet
Satzpille	Pellet primer
Satzring	Time train ring (TiFz)
Satzstück	Black powder pellet (TiFz); fuze composition disk
sauer	acidic; sour
Sauerstoff	Oxygen (lit Sour substance)
Sauerstoffträger	Oxidizer (lit Oxygen carrier)
Säule	Column; pile; pillar
Säure	Acid; sourness; acidity
Säuremesser	Acidimeter
S-Boot	See Schnellboot
Schabe	Scraper; grater
Schablone	Stencil; template; model; pattern
Schacht	Shaft (mining); bomb rack
Schachtel	Box; case
Schaft	Shaft; stock; handle
Schale	Dish; basin; bowl; husk; bark
Schall	Sound; ring; resonance
Schalldämpfer	Silencer (Ord); muffler
Schallwelle	Sound wave
schalten	to insert; shift; switch
scharf	sharp; pointed; acute; armed; primed; live (Ammo)
scharfe Munition	Live ammunition; service ammunition
scharfe Panzermine	Activated A/T mine
scharfe Patrone	Live cartridge; ball cartridge
scharfgeladene Granate	Live shell
scharfmachen; scharfstellen	to arm (Ammo); to activate a mine; to fuze a shell
Scharfschütze	Sharpshooter; sniper
Scharfschützengewehr	Sharpshooter's rifle
Scharnier	Hinge; joint
Schaufel	Shovel; scoop; paddle; blade
Schaum	Foam; froth; scum; lather
Scheibe (Schb)	Disk; plate; practice target; pane (of glass)
Scheibenpulver	Disk propellant
Scheibenwischer	Windshield wiper
Scheide	Scabbard; sheath
Scheinmine	Dummy mine
Scheinwerfer	Searchlight; projector; spotlight; headlight
Scherdraht	Shear wire
Schere	Shears; scissors
Scherfestigkeit	Shearing strength
Scherplatte	Shear plate
Scherstift	Shear pin
Schiedsrichter	Umpire (maneuvers)
Schiefer	Slate; schist; shale
Schiene	Rail; strip; surgical splint
Schiessbaumwolle; Schiesswolle	Guncotton
Schiessbecher	Rifle grenade launcher (discharger)
Schiessen	Gunnery
schiessen (schoss, geschossen)	to shoot; fire
Schiessplatz; Waffenprüfungsstelle	Proving ground; artillery range
Schiesspulver	Gunpowder
Schiess-stock (am Granatwerfer)	Rifle grenade rod
Schiess-stoffwesen	Powder business; all that concerns propellants and explosives
Schiesswesen; Schiesslehre	Gunnery; Ballistics (See also Artilleriewesen)
Schiesswollpulver	Guncotton propellant
Schiff	Ship; vessel
Schiffbauwerft; Schiffswerft	Shipyard
Schiffskanone (SK)	Naval gun
Schild	Shield; label; signboard
Schirm	Screen; umbrella; parachute; cover (See also Fallschirm)
Schirmlafette	Gun mount protected with a shield
Schlacht	Battle
Schlachtfliegerbombe	Fragmentation bomb carried by a fight plane
Schlachtflotte	Battle fleet
Schlacke	Slag; cinder; clinker (in coal)
Schlag	Shock; stroke; blow
Schlagbolzen	Firing pin; inertia striker pellet (Fz)
Schlagempfindlichkeit	Sensitivity to shock (to blow or to impact)
Schlagfeder	Striker spring (Fz)
Schlagladung	Booster charge; magazine charge (Fz)
Schlaglot	Hard solder
Schlagrohre	Percussion tube; friction tube (primer)
Schlagstift	Striker (Fz)
Schlagversuch; Schlagprobe	Impact test; percussion test
Schlagwetter	Firedamp
schlagwettersicher	Safe against firedamp
Schlagwetterversuchsstrecke	Testing gallery
schlagwetterzündfähig	ignitable by firedamp
Schlagzünder	Impact fuze; percussion fuze
Schlagzündschraube	Threaded percussion primer
Schlamm	Mud; sludge; slime; slurry
Schlange	Snake; coil; hose (flexible tube); spiral
Schlauch	Tube; tubing; pipe (flexible); hose
Schlauchboot	Pneumatic raft
Schlauchklemme	Tube clamp
Schleifmittel	Abrasive
schleppen	to tow; drag
Schlepper	Tractor; tug
Schlepptorpedo	Towed torpedo
Schleuder	Centrifuge; sling; catapult
Schleuderguss	Centrifugal casting (foundry)
Schleudermachine; Abschleuder-machine	Centrifugal machine; catapult
Schleudermine	Sling mine; sliding mine
Schleuderstart	Catapult take-off (Avn)

Schlieren (pl)	Streaks; striae; schlieren (regions of varying refraction, as in liquids and gases)
Schliff	Grinding; sharpening
Schlitten	Sled; sleigh; sleigh mount; sliding carriage (G)
Schlitz	Slit; slot; fissure
Schloss	Lock; bolt mechanism; castle
Schlot; Schlotte	Smoke stack
Schlüssel	Key; wrench; cipher code
Schlüsselgraben	Main trench
Schlüsselmine	Antivehicle mine laid as road block (lit Key mine)
Schmalspurbahn	Narrow-gage railroad
Schmelzpunkt	Melting point
Schmer	Fat; grease; suet
Schmergel	Emery
Schmetterling	Butterfly (nickname of a guided missile)
schmiedbar	malleable
Schmiede	Forge; smithy
Schmiedeeisen; geschmiedetes Eisen	Wrought iron; forged iron; malleable iron
Schmiermittel; Schmierstoff	Lubricant
Schmieröl	Lubricating oil
Schmierung	Lubrication
Schmirgel	Emery
Schnabel	Beak; bill; nozzle; nose
Schnalle	Buckle; clasp; gunsling hook
Schnauze	Snout; mouth; nose; nozzle; spout
Schnecke	Worm (Mech); endless screw; spiral
Schneckentrieb; Schneckenrad	Worm gear
Schneekette	Snow chain; skid chain
Schneewanne	Boat-type runner placed under gun carriage wheels for operations in deep snow
Schneide	Edge (of a knife, bayonet, etc)
Schneider	Cutter; Tailor
Schnellboot; S-Boot	Motor torpedo boat; PT-Boat; E-Boat
Schnellfeuergeschütz	Rapid-fire gun; quick-firing gun
Schnellfeuerkanone	Rapid-fire cannon; quick-firing cannon
Schnell Ladekanone	Rapid loading gun
Schnell Ladverschluss	Rapid loading breechblock
Schnell Ladung	Emergency demolition charge
Schnell Lot	Soft solder
Schnellzünder	Instantaneous fuze; nondelay fuze (See also empfindlicher Zünder)
Schneppe	Spout; snout; nozzle; lip
Schnitt	Cut; slice; section; intersection
Schnur (See also Zündschnur)	Rope; cord; twine; string
schräg	oblique; sloping; inclined
Schräglinie	Diagonal
Schrank	Cabinet; case; closet; cupboard
Schrapnell (S; Schr)	Shrapnel
Schrapnellmine (S-Mi; SchrMi)	Antipersonnel mine (lit Shrapnel mine) (See also Schützenmine)
Schraube	Screw; propeller
Schraubenflugzeug	Helicopter
Schraubenmutter	Nut (Tech)
Schraubenschlüssel	Wrench
Schraubenzieher	Screw driver
Schraubkappe	Screw cap
Schraubstock	Vise (Tech)
Schreck	Fright; terror
Schreckladung; Schreckmine	Booby trap; booby mine (See also Sprengfalle)
Schrot	Shot (for shotgun); pellet; cut; piece
Schrotgewehr	Shotgun
Schrotpatrone	Shotgun shell
Schuh	Shoe; SA scabbard or bolster
Schulbombe	Training bomb; dummy bomb
Schuld	Debt; fault; blame
Schü-Mine	Same as Schützenmine
Schuppe	Scale; flake
Schuss	Shot (discharge of a firearm); round of ammunition; blast
Schussbeobachtung	Observation of fire (Arty); spotting
Schussbereich	Range of gun; danger zone
Schussfolge	Rate of fire
Schusstafel	Range table; firing table
Schussversager	Dud; miss
Schusswaffe	Firearm
Schussweite (grösste Schussweite)	Range (See also Entfernung) (Maximum range)
Schusswinkel	Firing angle
Schütteltrichter	Separatory funnel
Schüttkasten	Container with a number of small bombs; "Molotov Breadbasket"; bomb magazine
Schütz	Relay (Elec)
Schütze	Private (infy); rifleman; sharpshooter
Schützengrabenkanone	Trench gun; trench mortar
Schützenhöhle	Dugout; foxhole
Schützenmine (SchüMi; S-Mi)	Antipersonnel mine (See descriptive part)
Schützenpanzerwagen (SPW; SPzWg)	Multipurpose armored car (used for carrying troops or equipment) (See also under Panzer)
Schutzfeder (SF)	Protective spring; safety spring
Schutzglas	Bulletproof glass
Schutzschild	Protective shield
Schutzstaffeln (SS)	Elite guard of the Nazi party
Schutzwall	Protective wall (system of land defenses, such as Westwall)
Schwaden	Suffocating vapor or exhalation; gas cloud; noxious gases; detonation products
Schwadron	Troop (Cavy)
schwängern	to impregnate; saturate; inseminate
Schwankung	Fluctuation; variation; oscillation
Schwanz	Tail; trail (G)
Schwarzkreuz	Black cross (Ger marking for diphenylcyanarsine) (CWS)
Schwarzpulver	Black powder
Schwebe	Suspension; sling
schwedisch	Swedish

schwedisches Hölzchen	Safety match (lit Swedish match)
Schwefel	Sulfur
Schwefelantimon	Antimony sulfide (Sb_2S_3)
Schwefelsäure	Sulfuric acid
Schwefeltrioxide	Sulfur trioxide (CWS)
Schwefelwasserstoff	Hydrogen sulfide
Schwefligsäure; schweflige Säure	Sulfurous acid
schweissen	to weld; sweat
schwelen	to burn slowly; smolder
Schwelkerze	Smoke candle (CWS)
schwellen	to swell; distend
Schwemmstein	Pumice stone
schwer	heavy
schwere Artillerie (sA)	Medium artillery (lit Heavy artillery)
schwere Haubitze (sH)	Medium howitzer (lit Heavy howitzer)
schwere Kanone (sK)	Medium gun (lit Heavy gun)
schwere Panzerbüchse	Heavy antitank gun
Schwerkraft	Force of gravity
schweres Maschinengewehr	Heavy MG
schwerste Artillery (ssA)	Heavy artillery (lit Heaviest artillery)
Schwert	Sword
Schwimmweste	Mae West; life vest
Schwingung; Schwung	Vibration; oscillation
schwirren	to whizz; buzz; centrifuge
Schwunggewicht	Pendulum
Schwungkraft	Vibrating power; centrifugal force
Schwungmaschine	Centrifuge
Schwungrad	Flywheel
Seefliegerei; Seeflugwesen	Naval aviation
Seeflugzeug	Seaplane; hydroplane
Seele	Bore (of a gun)
Seelenachse	Axis of the bore
Seelendurchmesser; Seelenweite	Diameter (caliber) of the bore (See also Kaliber)
Seelenlänge	Gun barrel length
Seelenrohr	Tube; liner (of a gun)
Seemeile	Nautical mile (1.853 km)
Seemine	Sea mine; underwater mine; submarine mine
Seeminensperre	Submarine mine field
Seezünder	Hydrostatic bomb fuze (in depth charges)
Segelflugzeug	Glider; sailplane
Segler	Sailboat; glider
Segmentgranate	Segmented shell
Sehrohr	Periscope; telescope (lit Seeing tube)
seigern	to exude
Seite	Side; face; direction (Gnry)
Seitenfeuer	Enfilade fire
Seitengewehr	Bayonet (lit Side arm)
Seitenverschiebung	Drift correction
Seitenwagen	Sidecar
Seitwärtsbewegung	Yawing (See also Pendeln des Geschosses)
Sekundärladung	Secondary charge; base charge (of a detonator)
Selbstentzündung; Selbstzündung	Spontaneous ignition
Selbstfahrlafette (Sf; Sfl)	Self-propelled (SP) mount; gun motor carriage (See also under Panzer)
(Geschütz auf Selbstfahrlafette)	(Self-propelled gun)
Selbstladeeinstecklauf	Subcaliber barrel for semiautomatic weapon
Selbstladegewehr	Semiautomatic rifle; self-loading rifle
Selbstladepistole	Semiautomatic pistol; self-loading pistol
Selbstlader; Selbstladewaffe	Semiautomatic weapon; self-loading weapon
Selbstschrumpfung	Self-shrinkage
Selbstverbrennung	Self-destroying type of fuse
Selbstzersetzung	Spontaneous decomposition
Selbstzündung	See Selbstentzündung
Sender; Sendegerät	Radio transmitter
Sendung	Shipment; transmission (Rad)
Senfgas; Yperit	Mustard gas (CWS)
senkrecht	vertical; perpendicular
Senkung	Sinking; lowering; hollow; depression
Sensibilität	Sensitivity; sensitiveness
Serienfabrikation	Production in series
Sesshafter Kampfstoff	Persistent chemical warfare agent
S-Geschoss	See Spitzgeschoss
sicher	safe; secure
Sicherheitsbottich	Safety tank; drowning tank
Sicherheitsdraht	Safety wire (Ord)
Sicherheitsglas	Safety glass; shatterproof glass
Sicherheitsminenpulver	Safety blasting powder
Sicherheitssprengstoff	Safety explosive
sichern	to make safe; lock (Ord and Ammo); cover; protect; make secure
Sicherungskappe	Safety device (Fz); safety cap (HdGr)
Sicherungsklappe	Safety valve; safety hatch
Sicherungsmutter	Lock nut
Sicherungsstift	Safety pin (Fz)
Sicherungsvorstecker	Arming pin (Fz); safety pin (B)
Sicherungszünder	Safety fuse
Sicht	Sight; visibility
Sichtfeld	Field of view
Sieb	Screen; sifter; filter
Siedepunkt	Boiling point
Siegfried Kanone	380 mm Railway Gun (See under Weapons)
Signalbombe	Signal flare
Signalpatrone	Signal cartridge
Signalrakete	Signal rocket
Signalwerfer	Ground signal projector
Siliziumtetrachlorid	Silicon tetrachloride
Sinkstoff	Deposited matter; sediment
Sipo (Sicherheitspolizei)	Security police
SM; S-Mine; SchüMi	See Schrapnellmine and Schützenmine
S-Mine Verbindungsstück, Drilling	Three-way adapter for S-Mine
Sockellafette (Skl)	Pedestal mount (G)
Sog	Suction

soggen	to crystallize out; precipitate
Sohle	Sole; bottom of a trench
Soldat	Soldier
Solvens (pl Solvenzien)	Solvent
Sonder	Separate; special; exclusive
Sonderartillerie	Heavy artillery (lit Special artillery)
Sondergerät (SGer)	Device serving a special purpose
Sonderkartusche (SKart)	Special propelling charge in non-fixed ammunition; super-charge cartridge
Sonderkraftfahrzeug (SdKfz)	Specialized vehicle, such as tank, tank destroyer, etc (See also under Panzer)
Sonderladung; Ausnahmeladung	Super-charge
Sondermunition (Smu; SdMu)	Non-fixed ammunition; special purpose ammunition
Sonderwaffe (SdW)	Special purpose weapon
Spähwagen (SpWg)	Scout car; reconnaissance vehicle
sPak	See under Ger Abbreviations
Spalt; Spalte	Crack; split; slit; fissure
Spaltanlage	Cracking installation; splitting device
Spaltanlage zur Gewinnung von Oleum aus Rücksäure	Installation for recovering oleum from spent acid by splitting process
Spaltfunkzünder	Jump-spark electric igniter
Spaltglühzünder	High-tension electric igniter
Spaltring	Split ring (breechblock)
Spaltzünder	High-tension detonator
Spaltzündermaschine	Exploder for high-tension detonator
Spannvorrichtung	Cocking mechanism
Sparstoff	Scarce material; high priority material
Spartgras	Esparto grass
Spätzerspringer	Retarded burst; delayed action projectile
Spätzünder; Verzögerungszünder	delay fuze
Spätzündung	Retarded ignition
Speer	Spear
Sperrballon	Barrage balloon
Sperre	Block; obstacle; barrier
Sperrfeuer; Notfeuer	Barrage fire; barrage
Sperrholz	Plywood
Sperrohr	Outer steam tube of MG
Sperrversuchsanstalt (SVA)	Naval establishment working on development and testing of sea mines
spezifisches Gewicht	Specific weight
Spiegel	Mirror; periscope; stern (of a ship)
Spiegeltelegraph	Heliograph
Spiegelvisier	Mirror sight
Spindel	Spindle; pinion; gear shaft
Spiralbohrer	Twist drill; spiral drill
Spiralfeder	Spiral spring; helical spring
Spitze (S)	Point; tip
Spitzgeschoss (S; SGesch)	Pointed bullet
Spitzgeschoss mit Eisenkern (SmE)	Pointed bullet with iron core; SAP bullet
Spitzgeschoss mit Stahlkern (SmK)	Pointed bullet with steel core; AP bullet
Spitzgeschoss mit Stahlkern (gehärtet) [SmK (H)]	Pointed bullet with hardened steel core; super AP bullet
Spitzgeschoss mit Stahlkern und Glimmspur (SmK-Gl'spur)	Pointed bullet with steel core and dim tracer
Spitzgeschoss mit Stahlkern und Leuchtspur (SmKL'spur)	Pointed bullet with steel core and tracer
Spitzmunition (SMu)	Pointed bullet ammunition
Spleissung; Splissung	Splice
Splint	Splint; cotter pin; split pin
Splitter; Sprengstück	Splinter; fragment (Proj)
Splitterbetonbombe (SplBeB)	Concrete fragmentation bomb
Splitterbombe (SplB)	Fragmentation bomb; A/P (antipersonnel) bomb
Splitterdichte	Density of fragments (number of shell fragments per unit area)
Splittergranate (SplGr)	Fragmentation shell; grenade
Splitterring	Fragmentation sleeve fitting over casing of the Stielhandgranate (lit Splitting ring)
Splitterschutzbrille	Protective goggles
splittersicher	splinterproof
Sporn	Trail spade (G); spike (MG tripod)
Sprachrohr	Megaphone
Spreizlafette	Split trail spade carriage
Sprengarbeit	Blasting job
Sprengbombe (SB; SprB)	HE bomb; demolition bomb
Sprengbombe, dickwandige	HE bomb, thick-walled
Sprengbrandbombe (SprBrB)	HE-Inc bomb
Sprengbüchse	Demolition charge in a container; petard
Sprengbüchse 02/24	Demolition charge consisting of a box containing 1 kg TNT
Sprengdienst (Sd)	Demolition service
sprengen	to blast
Sprengfalle	Booby trap (See also Schreckladung)
Sprengfüllung	Filler; HE filling charge
Sprengflüssigkeit	Explosive liquid
Sprenggelatine; Sprenggummi	Blasting gelatin
Sprenggranate (Sprgr)	HE shell
Sprenggranate 41 (Sprgr 41)	HE shell pattern 41, for a tapered bore gun
Sprenggranate-Patrone (SprgrPatr)	HE shell in a cartridge; (complete round of fixed ammunition)
Sprenggummi	See Sprenggelatine
Sprengkammer	Mine chamber (blasting)
Sprengkapsel	Detonator; blasting cap; initiator
Sprengkapsel Nr 8 (Al)	Detonator No. 8 (Aluminum)
Sprengkapselzünder (7.5, 10, 25 Sekunden)	Detonating cord unit with blasting cap and fuse lighter; prepared demolition set
Sprengkapselzünder 28 (kurz)	Prepd demolition set with delay 100 sec
Sprengkapselzünder 28 (lang)	Prepd demolition set with delay 200 sec
Sprengkörper	Demolition block; prepared charge
Sprengkörper 28	Demolition slab, 200 g
Sprengkörper 88	Demolition charge consisting of a box containing 200 g picric acid

Sprengkörper Tp	Demolition slab, 200 g in bakelite container (for tropical climates)
Sprengkraft	Explosive force
Sprengladung (Sprldg)	Bursting charge; demolition charge; blasting charge
Sprengladungsröhre	Burster tube (Proj)
Sprengloch	Blast hole
Sprengluft	Liquid-air explosive; oxyliquit
Sprengmittel	Explosive in prepared form, as distinguished from generic term Sprengstoff; HE demolition charge
Sprengmittelkasten Satz	HE charges and accessories
Sprengmunition	Explosive ammunition
Sprengmunition 02	Trinitrotoluene (TNT) charge
Sprengmunition 88	Picric acid (PA) charge
Sprengniete	Explosive rivet
Sprengöl	Nitroglycerin (NG); detonating oil
Sprengölpulver	NG propellant; double base (NG-NC) propellant
Sprengpatrone	Blasting cartridge (demolitions); explosive bullet
Sprengpatrone Zerstörer	Gun destructor charge
Sprengpulver	Blasting powder; black powder
Sprengsalpeter	Nitrate explosive
Sprengsatz	Bursting charge; explosive filler
Sprengschlag	Explosion
Sprengschnur	Fuse (lit Explosive cord)
Sprengstoff	Explosive; HE (See also Sprengmittel)
Sprengstoffart	Type of explosive
Sprengstofffüllung	HE filler (Ammo)
Sprengstoff, Lose	HE bulk
Sprengstoffwesen	Subject of explosives; all that concerns explosives
Sprengstück	See Splitter
Sprengtechnik	Technics of manufacture of explosives; technics of demolitions
Sprengtrichter	Mine crater
Sprengung	Demolition; blasting
Sprengwirkung	Explosive effect; bursting effect
Sprengzünder	Detonating fuse; primacord
springen	to burst; break; crack
Spritzdüse	Injection nozzle; steam injector
Spritzform	Injection mold; jet mold
Spritzguss	Injection molding; die casting
Spritzgussmasse	Injection molding composition
Spritzweite	Range (of flamethrower)
Spule	Spool; electric coil
Spülung	Rinsing; washing; flushing
Spur	Trace; track; trail
Spur (S); Leuchtspur (L'spur)	Tracer
Spurgeschoss	Tracer projectile
SS	See Schutzstaffeln
SS-Panzerkorps	SS armored corps
Stab	Staff; rod; bar
Stabbrandbombe	Stick-type incendiary bomb
Stäbchenpulver (StbP)	Chopped tube propellant
Stabilität	Stability (See also Beständigkeit and Haltbarkeit)
Stabmine	Stick mine
Stachelbombe (Stabo)	Bomb with long nose spike (See description)
Stacheldraht	Barbed wire
Staffelfeuer	Echelon fire

Stahlblechpanzer	Steel plate; sheet steel armor
Stahlgeschoss; Stahlgranate	Light case shell of cast steel
Stahlguss	Cast steel
Stahlhelm	Steel helmet
Stahlhütte; Stahlwerk	Steel works
Stahlkerngeschoss	Steel-core bullet; armor-piercing bullet
Stahlmantelgeschoss	Steel-jacketed bullet
Stahlmörser	Steel mortar
Stahlpanzer	Steel armor
Stahlseele	Steel liner (G)
Stahlspitzengeschoss	Steel pointed bullet
Stahlwerke	Steel foundry
Stalag (Stammlager)	Prisoner of war camp for NCO's, privates and labor detachment
Stammkörper; Stammsubstanz	Parent substance
Standort	Post; garrison; station; position
Stange	Pole; post; pillar; bar; rod
Stangenkugel	Crossbar shot; double-headed shot
Stangenladung	Pole charge (See general section)
Stangenladung	Pole-charge antipersonnel mine
Stapel	Staple; warehouse; pile; launching cradle
Stärke	Starch; strength; thickness
Startkatapult	Catapult
Startvorrichtung	Launching device
Stativ	Stand; support; tripod
Staub	Dust
Staubpulver (StbP)	Finely granulated powder
stauchen	to compress (by blow); knock
Stauchlafette	Retractable (telescopic) gun carriage
Stauchprobe	Compression test; crusher test
Stauchzylinder	Crusher cylinder
Stearinsäure	Stearic acid
stechen	to stick; prick; pierce; puncture
stecken	to stick; stay; remain
Stecker	Plug (Elec)
Steckzünder 40	Inserted rocket igniter, pattern 40
steil	steep
Steilbahn	High-angle trajectory
Steilfeuer	High-angle fire; curved fire
Steilfeuergeschütz (Haubitze)	Howitzer (lit High-angle fire gun)
Stein	Stone; rock
Steinbruch	Quarry
Steinflachs	Asbestos
Steinkohle	Mineral coal; anthracite
Steinkohlenpech	Coal tar
Steinschlossgewehr	Flintlock gun
Stellmutter	Lock-nut; regulating (adjusting) nut
Stellring	Adjusting ring (Fz); time-setting ring
Stellschlüssel	See Stellstift
Stellschraube	Set screw; adjusting screw

Stellstift; Stellschlüssel (St)	Fuze setter
Sternbündelpatrone	Star cluster cartridge (signal); multiple star cartridge
Sternpulver (StP)	Star-shaped propellant
Sternsignal	Signal flare; star signal
Steuer	Control; steering wheel; tax
Steuerflügel	Stabilizing fin (B)
Steuerung	Steering
Stich	Thrust; stab; sting
Stichprobe	Sample taken at random
Stichwaffe	Thrusting weapon
Stickstoff (N)	Nitrogen
Stickstoffsäure; Stickstoffwasserstoffsäure; Stickstoffwasserstoff	Hydrazoic acid; hydronitric acid; hydrogen trinitride (HN_3)
Stiefel	Boot; case; barrel
Stiel	Handle; shaft; stem; stalk
Stielgranate (Stgr)	Stick grenade; rodded bomb
Stielgranate 41	37 mm Rodded bomb for A/T gun, Pak 41
Stielhandgranate (Sthgr)	Hand grenade with handle; potato-masher hand grenade
Stift	Pin; peg; tack; stag
Stirnpanzer	Front armor
Stock	Stick; cleaning rod (Rf); picket; pole
Stockmine (StoMi)	A/P picket-type mine; stake mine (of concrete)
Stoff	Substance; stuff; fabric; material
Stofflehre	Same as Chemie
Stollen	Gallery; tunnel
Stolperdraht	Trip wire
Stolperdrahtfeld	Field of trip wire obstacles
Stolperdrahtmine	Trip wire mine
Stopfbüchse	Gland; stuffing box
Storch	Liaison airplane
stören	disturb; trouble; harass
Störungsfeuer	Harassing fire (Arty)
Stoss	Impulse; thrust; shock; blow; push
Stossdämpfer	Bumper
Stössel	Pestle; rammer; tappet (Fz)
Stossempfindlichkeit	Sensitivity to shock (Expl)
Stossempfindlichkeitsprobe	Test for sensitiveness to shock
stossen	to push; thrust; strike
Stosskappenmine; Stossmine	Contact mine (Nav)
Stosskraft	Percussive power, impact
stossreizbar; stossempfindlich	sensitive to shock
stoss-sicher	insensitive to shock
Stossversuch	Shock test (Expl)
Stosswaage	Ballistic pendulum
Stosswelle	Shock wave; percussion wave
Stosszünder	Percussion fuze
Strahl	Ray; jet (of liquid or gas); flash (of lightning)
Strahlung	Radiation; radiance
Strandmine (StdMi)	Beach mine; shore mine
Strecke	Distance; space; stretch; drift (Mining)
strecken	to stretch; extend; flatten; roll (metal, glass)
Streckstahl	Rolled steel
streichen	to cross out; strike out; eliminate

Streichholz; Streichzündhölzchen	(Friction) match
Streifen	Band; strip; stripe; belt; sector
Streifenlader	Magazine clip (Rf)
Streifenpulver (StrP)	Strip (band or lamellar) propellant
Streit	Contest; combat; strife; dispute
Strenglot	Hard solder
Streubrandbombe	Scatterfire bomb
streuen	to scatter; strew; cover with zone fire (Arty)
Streufeuer; Streuungsfeuer	Zone fire (Arty); sweeping fire
Streugarbe	Cone of dispersion
Streukegel	Sheaf of fire; cone of fire; cone of dispersion; cone of spread
Streumine	Uncontrolled mine; stray mine (not laid to regular pattern)
Streuung	Dispersion (Ball); scattering; deviation
Strichfeuer; bestreichendes Feuer	Grazing fire
Strohzellstoff	Straw pulp
Strom	Stream; current; flow; electric current
Stromerzeuger	Generator (Elec)
Stromliniengeschoss	Streamlined bullet; boat-tailed bullet
Strommesser	Ammeter; current meter
Stromstärke	Amperage
Strömung	Current; flowing; flood; magnetic flux
Stück; Geschütz	Piece (Arty); gun; cannon
Stufe	Step; stage; degree; rank
Stuka (Sturzkampfflugzeug)	Dive fighter bomber
Stukaflieger	Dive fighter bomber pilot
Stumpf	Stump
stumpfer Winkel	Obtuse angle
Sturm (Stu)	Assault; storm
Sturmartillerie (StuA)	Assault artillery
Sturmgeschütz (StuG)	Assault gun (SP G)
Sturmgewehr 44 (StuG 44)	Stormtrooper's rifle (previously called Maschinenpistole 44)
Sturmkanone (StuK)	Assault cannon (SP)
Sturmmörser (StuMrs)	SP Assault rocket projector (See under Panzer)
Sturmpanzer (StuPz)	Assault tank; front line support armored vehicle supplying overhead fire power (See also under Panzer)
Sturmpanzer 43	Same as Brummbär (See under Panzer)
Sturmwind	Storm wind
Sturz	Plunge; dive; fall
Sturzangriff	Diving attack
Sturzbomben	Dive-bombing
Stürze	Lid; cover
Sturzflamme	Reverberatory flame
Sturzflug	Dive
Sturzkampfflugzeug (Stuka)	Dive bomber
Stütze	Support; stay; prop
Stützschraube (StzSr)	Support screw
Stuvi (Sturzvisier)	Dive Bombing sight

Styphninsäure	Styphnic acid; trinitroresorcinol
Suchanker	Grapnel
Sumpfgas; Sumpfluft	Marsh gas; methane
Surrogat	Substitute (See also Ersatz)

T

T-38 (Panzer)	One of the tanks developed by Skodawerke (See under Panzer)
Tabelle	Table; chart
Tag-Tonne (TATO)	Metric tons per day
Tak	Antitank gun (A/T gun)
Takartillerie	A/T artillery
Tank; Tankwagen	Tank
Tankbüchse	A/T rifle
Tankgraben	A/T ditch
Tarngerät	Camouflage equipment
Tarnmittel	Camouflage material
Tarnung	Camouflage
Taschenmunition	Small arms ammunition in pouches
Taster	Calipers; key; feeler; antenna
Taucher	Diver (Nav) (See also Torpedotaucher)
technischrein	technically pure; correct
Technische Nothilfe (Teno)	Technical Emergency Corps
Teer	Tar
Teerasphalt	Coal-tar pitch
teilen	to divide; graduate; share
Teilkartusche; Teilladung	Increment charge; partial propellant charge (SL Ammo) (See also Vorkartusche)
Teilkerngeschoss	Sectional bullet
Teilladung	See Teilkartusche
Teilmantelgeschoss	Semi-jacketed bullet
Teilmantelhohlspitzgeschoss	Semi-jacketed hollow point bullet
Teilmantelspitzgeschoss	Semi-jacketed pointed (spitz) bullet
Teilring	Graduated ring
Teilscheibe	Graduated dial; dial-sight; quadrant
Teilstrich	Graduation mark; mil (Arty)
Telefunken	German company manufacturing electronic equipment
Teller	Disk; seat of a valve; plate
Teller (Zünder)	Time-scale (Fz)
Tellermine (TMi)	Disk-type A/T mine
Temperstahl	Annealed steel
tempieren	to set a fuse
Tempierring	Fuze time setting ring; time scale (Fz)
Teno	See Technische Nothilfe
Tesching	Small bore rifle
Teufe	Depth (Mining)
Theodor Bruno (Kanone)	240 mm Railroad Gun (See under Weapons)
Theodor (Kanone)	240 mm Railroad Gun (See under Weapons)
Thermit	Thermite
Thermitbombe	Thermite (incendiary) bomb
Thermitladung	Thermite charge (Inc B)
Thor	Heavy SP mortar (See Thor and Karl Mortars)
Tiefe	Depth; deepness; deep
Tiefenbombe	Depth charge; depth bomb
Tiegel	Crucible; melting pot
Tiegelfluss-stahl; Tiegelguss-stahl	Crucible cast steel; crucible steel
Tierarzt; Veterinär	Veterinarian
Tiger I	Heavy tank (See under Panzer in descriptive part)
Tiger II (Königstiger)	Heavy tank (See under Panzer in descriptive part)
Tiger Jäger	Same as Jagdtiger (See under Panzer)
Tiger (P)	Heavy tank-destroyer designed by Porsche (See under Panzer)
Titerapparat; Titrierapparat	Titrating (volumetric) apparatus
T-Mine	See Tellermine
tödliche Menge	Killing concentration (CWS)
Tolit	Trinitrotoluene (TNT)
Ton	Tone; sound; clay
Tonerde	Alumina; argillaceous earth
Tonne (TO)	Metric ton = 1000 kg or 1.102 short tons; buoy (Navy); drum; barrel; cask
Tonwagen	Sound truck
Tonwiedergabe	Sound reproduction
Topf	Pot; jar; crock; hand grenade casing
Topfmine; To-Mine	Pot-shaped land mine
Torf	Peat
Torfkohle	Peat charcoal
Torfmehl	Powdered peat
Torpedoabschussvorrichtung	Torpedo-launching device
Torpedoabwehrgeschütz	Anti-torpedo gun
Torpedoabwurf	Torpedo release (Avn)
Torpedoausstossrohr	Torpedo tube
Torpedobootzerstörer	Destroyer (Nav)
Torpedoflieger	Torpedo-bomb pilot (Avn)
Torpedoflugzeug	Torpedo bomber (Avn)
Torpedogeschoss	Streamlined (boat-tailed) bullet
Torpedogranate	Torpedo shell
Torpedorohr	Torpedo-launching tube
Torpedoschnellboot	Motor torpedo boat
Torpedoschutznetz	Torpedo defense net
Torpedotaucher	Deep-sea diver (See also Taucher)
Torpedowurf	Torpedo release (Avn)
totpressen	to dead press
Totschläger	Blackjack
Tragantgummi	Gum tragacanth
tragbar	portable; productive
tragen	to bear; carry; support
Träger	Carrier; mount; support; beam
Traglasten	Pack load
Tragweite	Range
Tränengas	Tear gas; lacrimator
Tränenstoff (T-Stoff)	Lacrimator
transportsicherer Zünder	Shipment-safe fuze
treffen	to hit; strike; meet; take measures
Treffpunkt	Point of impact; objective point (Arty)
treiben	to drive; propel; impel; drift
Treibgas	Propelling gas; wood gas
Treibgasmotor	Wood-gas engine
Treibladung; Treibsatz	Propelling charge; propulsive charge

Treibmine	Floating mine; an anchored automatic contact mine
Treibmittel	Propulsive agent
Treibpulver	Propellant; propellent powder
Treibspiegel	Sabot disc
Treibspiegelgeschoss	Sabot projectile (lit Disc projectile)
Treibsprengstoff	Propellant
Treibstoff	Engine fuel
Trennungsverfahren; Trennungsvorgang	Separation process
treten	to step; tread; pass; enter
Tretmine	Tread mine; pressure-ignited A/P mine
Trichter	Funnel; crater; cone
Trichterfeld; Trichtergelände	Terrain pitted with shell craters
Trichterladung	Crater charge
Trichtermine	Funnel mine
Trichterwirkung	Mine effect
Triebkraft	Motive power
Triebwerk	Power plant
Trilit	Trinitrotoluene (TNT)
Tripelerde; Trippelerde	Tripoli
trocken	dry
Trockner	Drier
Trog	Trough; vat
Trommel	Drum; cylinder of a revolver
Trommelfeuer	Drum fire; heavy barrage (Arty)
Trommelmagazin	Drum (cylinder) magazine
Trommelmagazinzuführung	Drum feed
Tropen (Tp)	Tropics
Tropfenflasche; Tropfflasche	Dropping bottle
Tropftrichter	Dropping funnel
Trotyl	Trinitrotoluene (TNT)
Trübungsgrad	Degree of turbidity
T-Stoff	See Tränenstoff; highly concentrated (80-85%) hydrogen peroxide

U und Ü

üben	to practice; exercise; train
Überborsäure	Perboric acid
Überchlorsäure	Perchloric acid
Überchromsäure	Perchromic acid
Überdruck	Excess pressure; pressure above 1 atm
Überführungszahl	Transport (transference) number
überhitzen	to superheat (steam); overheat (engine)
Überhitzer	Superheater
Übersalpetersäure	Pernitric acid
übersättigen	to supersaturate
Überschiessen (eigener Truppen)	Overhead firing
überschweres Maschinengewehr	Superheavy machine gun
Überschwefelsäure	Persulfuric acid
Überstrahlung	Overradiation; overexposure (to radiation)
übertragen	to transfer; transport; transmit; propagate waves
Übertragung	Transmission
Übertragungskörper	Induced-detonation charge
Übertragungsladung	Intermediate charge; booster; communication charge
Übertrommel	Range drum (sight mount)
Überwachung	Surveillance; observation; policing
Überwasserstreitkräfte	Surface forces (Nav)
U-Boot (Unterseeboot)	U-boat; submarine
U-Boot-Bunker	Submarine pen
U-Boot-Jäger	Submarine chaser
U-Bootkrieg	Submarine warfare
U-Boot-Mutterschiff	Submarine tender
U-Bootnetz	Submarine net
U-Boot-Werft	Submarine construction yard
Übung	Practice; exercise; training; drill
Übungsbombe	Practice bomb; dummy bomb
Übungsgeschoss	Training projectile; target-practice projectile; drill projectile
Übungsgranate	Practice shell
Übungshandgranate	Practice hand grenade
Übungsladung	Practice charge (Ammo)
Übungsmine	Practice mine
Übungsmunition	Practice ammunition
Übungspatrone	Practice cartridge
Übungsschiessen	Practice firing
Uhr	Watch; clock; timepiece
Uhrwerkantrieb	Clockwork action (Fz)
Uhrwerkzünder	Clockwork fuze
Uhrzeiger	Clockhand; indicator (instruments)
(im Gegensinn zum Uhrzeiger)	(Counterclockwise)
(im Sinne des Uhrzeigers)	(Clockwise)
Uhrzeit	Clocktime (such as 13 45 as distinguished from Zeit, which means "time length")
Ultrageschoss	High-speed bullet
Ultrakurzwelle	Ultrashort wave; ultra-high frequency wave (30 mc to 300 mc)
Umänderung	Conversion; change
Umdrehungszahl	Number of revolutions; rpm
Umfang	Circumference; perimeter; scope
umfassen	to embrace; comprise; envelop
Umformer	Converter (Elec)
umgeändert; umgearbeitet (umg)	Modified; converted; reworked
Umkreis	Perimeter; radius; circumference
umkristallisiert	recrystallized
umlaboriert	equipped; outfitted
Umlauf	Rotation; revolution; circulation
Ummantelung	Jacket; envelope; sheath
Umrandemaschine	Crimping machine
Umrandung	Edge; border
umrühren	to stir; stir up
Umschalter	Switch board; reverser; commutator
Umschlagspunkt	Transition point
unbewaffnet	unarmed
Unbrennbarmachung	Fireproofing
undicht	not waterproof or gasproof; permeable; leaky; not tight

undurchdringlich	impermeable; impenetrable
unendlich	infinite; endless
unentbehrlich	indispensable
unentzündbar	inert (Ammo)
unerlaubte Entfernung	Absence without leave (AWOL)
ungefähr	about; approximate
ungelöschter Kalk	Quick lime
unscharf	unarmed (Fz); out of focus (Optics)
unscharf machen	to disarm (Ammo)
Unterarzt	Interne; young physician
Unterbrecher	Interruptor
Unterchlorigsäure	Hypochlorous acid
Unterchlorsäure	Hypochloric acid
Unterdruck	Diminished pressure; vacuum; below atmosphere pressure
Unterfeldwebel	Staff sergeant
Unterführung	Underpass (RR)
Unterkalibergeschoss	Subcaliber projectile
Unterkühlung	Supercooling
Unteroffizier	NCO; corporal
Unterschied	Difference
Unterseeboot	See U-Boot
unterstützen	to support
Untersuchung	Investigation; examination; inspection
Untertauchung	Submersion; immersion
Unterwachtmeister	Staff sergeant (Cavy and Arty)
Unterwasserbombe	Depth charge; depth bomb
Unterwasserbrückenzünder	Underwater bridge primer
Unterwasserhorchgerät	Hydrophone (Nav)
Unterwassernebenschlusszünder	Underwater shunt primer
Unterwasserspaltzünder	Underwater split primer
Unterwassersprengung	Underwater blasting (Dem)
Unterwasserzünder	Underwater primer or fuze
Urbaumuster	Original model; prototype
Urstoff	Primary matter
Urwaldkrieg	Jungle warfare

V

V-1, V-2, and V-3	See Vergeltungswaffe
V_2A	Eins, etc. Brand of stainless steel used in German explosives plants.
Vakuumröhre	Vacuum tube
V-Boot; Verkehrsboot	Launch
Velocitas-Null (Vo)	Initial velocity; muzzle velocity
Ventil	Vent; valve
Ventildichtung	Valve gasket
ventilloser Motor	Sleeve-type engine
veraltet	obsolete; antiquated
veränderlich	variable; changeable; unstable
verankerte Mine	Moored mine
Veraschung	Ashing; incineration
Verausgabung	Issue
Verband	Binding; bandage; dressing; bond; combined arms unit
Verbandsabwurf; Verbandswurf	Formation release (bombing)
verbessert (v)	improved

Verbesserung	Correction (Gunny); improvement
Verbindung	Compound; union; joining; assembly; alloy (metal); liaison
Verbindungsstück	Adapter
Verbot	Prohibition; off-limits declaration
Verbrauchssatz	Consumption per 100 kilometers (gas and lubricants)
verbrennbar	combustible
Verbrennung	Combustion; burning; deflagration
Verbrennungsanalyse	Analysis by combustion
Verbrennungskraftmaschine	Internal combustion engine
Verbrennungsraum	Combustion chamber; propellant chamber; powder chamber
Verbrennungsrückstände	Residues of ignition (or combustion)
Verbrennungswärme	Heat of combustion
Verbrennungswert	Calorific power; combustion value
Verbundgeschoss (V)	Compound projectile (See Mantelgeschoss)
verchloren	to chlorinate
verchromt	Chromium plated
Verdämmen; Verdämmung (See also Besatz)	Tamping; mud capping (Dem); damming up (a stream)
verdampfen	to evaporate; vaporize
Verdampfungswärme	Heat of vaporization (or evaporation)
verdeckte Zündung	Covered priming
Verdichtungsapparat	Condenser
Verdichtungsstosswelle;	Compression wave; burst wave;
Verdichtungswelle	detonation wave
Verdickungsmittel	Thickening agent; thickener
verdünnen	to thin; dilute (liquids); rarefy (gases)
verdunsten	to evaporate
Verein; Vereinigung	Union; association; society
Vereinheitlichung	Standardization
Vereisung	Formation of ice; icing (Avn)
Veresterung	Esterification
Verfahren	Method; procedure; process
Verfall	Decay; deterioration; decline
Verfälschung	Adulteration; falsification; forgery
verfeinern	to refine; improve
verfertigen	to make; prepare; manufacture
verfeuern	to fire; launch; burn up
verflüchtigen	to vaporize; evaporate
Verflüchtigungsfähigkeit	Volatility
verflüssigen	to liquify; dilute
verfrüht	premature
Verfügung	Disposal; disposition; availability
Verfügung des Oberkommandos des Heeres	Army Regulation
Vergällung	Denaturing
vergären	to ferment
Vergaser	Gasifier; carburetor

Vergeltung	Retaliation; reprisal; revenge
Vergeltungswaffe (V)	Retaliation (revenge) weapon such as V-1, V-2 and V-3)
vergiessbar	castable; ready to cast
vergiften	to poison; contaminate (CWS)
Vergiftungsschiessen	Gas shell fire (Arty)
Verglasung	Vitrification; glazing
Vergleichsschiessen	Calibration fire (Arty); test shooting
Vergrösserung	Enlargement
vergüten	to improve; temper (metals); compensate
Vergütungsstahl	Heat-treated steel
Verhältnis	Proportion; ratio; rate
Verhärtung	Hardening
Verharzen; Verharzung	Resinification
Verholzung	Lignification
Verhüttung	Smelting; working off (metals)
Verjüngung	Taper; reduction (of scale)
verkanten	to cant; tilt; incline
Verkehrsboot	See V-Boot
verkehrt	reverse; inverse
Verkettung	Linking; linkage
Verkittung	Fastening (sealing) with putty or other adhesive; cementing
Verkleidung	Facing; casing; lining; disguise; camouflage
Verkleinerung	Diminution; reduction
verkleistern	to make into paste; to cover with glue; to stick together
verklemmen	to jam; wedge
verknallen	to detonate
verknistern	to decrepitate
Verknisterung	Decrepitation
verkobalten	to plate with cobalt
verkochen	to boil down; concentrate
verkohlen	to char; carbonize
verkoken	to coke
verkreiden	to calcify
verkühlen	to cool down
verkupfern	to copper
verkuppeln	to couple; to connect
verkürzte Leuchtspur (vk L'spur)	Shortened tracer trail
verkürztes Röhrenpulver	Tubular propellant cut into short lengths
Verlag; Verlagsbuchhandlung	Publishing house
verlasten	to pack or load on vehicles or horses
verlastete Artillerie	Pack artillery
verlastetes Geschütz	Pack piece (of ordnance)
verlöschen	to go out; be extinguished
verlöten	to solder
vermengen; vermischen	to mix; blend
vermessen	to measure; survey
Vermessungsbatterie	Ranging battery
verminderte Ladung	Reduced charge
verminen	to mine; lay mines
Vermögen	Ability; power; property
Vernebelung	Smoke screening
Vernichtung	Destruction; annihilation

vernickeln	to nickel-plate
vernieten	to rivet
Verordnung	Order; decree; regulation
Verpackung	Packing; casing
Verpackungsgeschoss	Dummy projectile for vehicle-loading practice
verplatinieren	to platinize
verpuffen	to puff off; deflagrate; explode
Verpuffungsprobe	Deflagration test
Verrichtung	Performance; execution; action
verrostet	rusty
Versager	Misfire; failure
Versäuerung	Acidification
verschiessen	to expand; fade; discharge
verschleiern	to mask; screen; veil; camouflage
Verschleierungsfeuer	Diversion fire; smoke-shell fire
Verschluss	Closing; closure; breechblock; breech mechanism
Verschlussblock	Screw-type breechblock
Verschlusskeil	Wedge-type breechblock
Verschlussring	Breech ring; closing ring
Verschlussschieber	Breech locking slide; shutter slide
Verschluss-schraube	Breech screw; threaded closing cap in fuze
Verschraubung	Screw joint; screw cap
Verschreibung	Prescription; order; note
Verschwindlafette	Disappearing gun mounting
versehen	to provide; supply; furnish
versilbern	to silver-plate
verspannen	to brace; tighten; stretch
versprühen	to spray (CWS)
Verstählung	Acieration; case hardening
Verstärkung	Reinforcement
Versuch; Versuchung	Experiment; assay; trail; test
Versuchladung	Test charge (Arty)
versuchs	experimental
Versuchschiessen	Test firing (Ord)
Versuchwesen	Research
verteidigen	to defend; maintain
Verteidigungswaffe	Defense weapon
verteilen	to distribute; divide
Verteilungsstelle	Distributing point
Vertiefung	Deepening; depression; cavity
vertrocknen	to dry up
verunreinigen	to render impure; contaminate
vervielfachen; vervielfältigen	to multiply
Verwendung	Application; use; utilization
Verwitterung	Efflorescence; weathering
Verzahnung	Gear; gearing
Verzeichnis	List; register; index
verzinken	to coat with zinc; galvanize
verzinnen	to tin; coat with tin
verzögern	to delay; postpone
Verzögerung (V)	Retardation; delay; lag

Verzögerungskörper	Delay element
Verzögerungsmine	Delay-action mine
Verzögerungssatz	Delay pellet in an electric igniter; delay powder train (Fz)
Verzögerungszünder	Delay fuze; delayed-action fuze
Verzug	Delay; lag
Verzugszeit (Vz)	Safety time (in fuzing)
Verzugszündung (VZ)	Safety fuzing
Verzweigung	Branching
Vieleck	Polygon
vielfach	manifold
Vielfach; Vielfache	Multiple
Vielfachwerfer (Raketen)	Multiple rocket launcher
Vielrohrgeschütz	Multiple barrel gun; Gattling gun
Viereck	Square; quadrangle
Vierfuss	Four-footed stand
Vierling	Four-tuber
Vierlings-Maschinengewehr	Four-barreled MG
Viertaktmotor	Four-cycle engine
visieren	to gage; aim; sight
Visiervorrichtung	Sight mechanism
V-Null (Vo); Velocitas-Null	Initial velocity; muzzle velocity
Vogeldunst	Bird shot; small shot
Volkssturmgewehr Eins (VGI)	People's rifle in last ditch defence
Volkswagen (VW)	People's car (designed by Porsche)
Vollbahn; Vollspurbahn	Standard-gage RR (1.435 meters)
Vollgeschoss	Shot; solid non-explosive projectile
Vollreifen	Solid tire
Vollrohr	Monoblock gun barrel
vollständiger Schuss; vollständiges Geschoss	Complete round of ammunition
Volltreffer	Direct hit
Vorderlader	Muzzle loader
Vorderlauf	Muzzle end of barrel
Vordruck	First impression; proof; blank
Vorgang	Process; chemical reaction; occurrence; event
Vorhalt	Lead (firing)
Vorholer	Counter recoil mechanism
Vorkartusche	Front increment propelling charge (SL Ammo) (See under Cordite Charge Casings in descriptive part)
Vorladung	Wadd; wadding
Vorlage (Vorl)	Flash-reducing wad (Arty); text; copy; pattern; something put in front
Vorlauf	Counter recoil
vormals	formerly
Vorprobe	Preliminary test
Vorrichtung	Contrivance; device; mechanism
Vorsignal	Warning signal; preliminary signal
Vorstecker	Safety pin (B, Mi and Gr); lug (Fz)
Vorsteher	Director; superintendent
Vorstoss	Adapter; attack; advance
Vortriebskraft	Propelling power
Vorwärmer	Preheater
Vorzündung	Preignition; premature ignition (Mot)
Vulkanfiber	Vulcanized fiber

W

Waage; Wage	Scales; balance
Wachregiment (Wa)	Guard regiment
Wachs	Wax
Wacht	Guard; watch; radar station (Avn)
Wachtmeister (See also Feldwebel)	Staff sergeant (Arty and Cavy)
Waffen	Weapons; arms
Waffenamt	Ordnance office (lit Weapons office)
Waffenlager	Ordnance depot
Waffenoffizier	Ordnance officer
Waffenprüfung	Ordnance testing
Waffenprüfungsplatz	Proving ground, such as at Hillersleben (Army) and Meppen (Navy)
Waffen und Gerät	Ordnance materiel
Wagen	Wagon; car; vehicle
wägen	to weigh; balance
Wägepipette	Weighing pipet
Wägeschale	Weighing dish
Wahrscheinlichkeitsfaktor	Probability factor
Walkerde; Walkererde	Fuller's earth (See also Wascherde)
Wall	Rampart; dam; embankment
Wallgraben	Moat; ditch
Walze	Roller; roll; cylinder; body (of a shell); drum (of a revolver)
Walzenmühle	Roller mill
Wälzlager	Ball or roller bearing
Walzwerk	Rolling mill
Wand	Interior wall; partition; bulkhead
Warenlager	Warehouse
Wärme	Heat; warmness
Wärmeausdehnung	Thermal expansion
Wärmebehandlung	Heat treatment
Wärmebeständigkeit	Resistance to heat
Wärmebilanz	Heat balance
Wärmebindung	Absorption of heat
Wärmeelektrizität	Thermo-electricity
Wärmegleichwert	Mechanical equivalent of heat
Wärmekraftlehre; Wärmemechanik	Thermodynamics
Wärmeleitfähigkeit	Thermal conductivity
Wärmeleitung	Conduction of heat

Wärmeprobe	Heat test
Wärmeregler	Thermoregulator
Wärmeübertragung (W)	Heat transfer
Wärmevermögen	Heat capacity
Warze	Lug; stud; nipple; knob
waschen	to wash; scrub
Wascherde	Fuller's earth (See also Walkerde)
Wasser	Water
Wasserbombe (Wabo)	Depth bomb; depth charge
Wasserdampfbad	Steam bath
wasserdicht; wasserfest	waterproof; water-tight
wassergierig	hygroscopic
Wasserhahn	Water tap; water cock
Wasserkunst	Water-work; draining engine (Mining); hydraulics
Wasserlinie	Waterline
Wassermantel	Waterjacket
Wassermörtel	Hydraulic mortar
Wasserprüfung	Water testing; water analysis
Wasserschiessprobe	Underwater firing test
Wasserstoff	Hydrogen (H)
Wasserstoff-hyperoxyd; Wasserstoff-peroxyd	Hydrogen peroxide (See also T-Stoff)
Wasserstoffzahl	Hydrogen ion concentration (pH)
Watte	Absorbent cotton; wadding
Wechsel	Change; displacement (Arty); exchange; currency
Wechselgetriebe; Getriebe	Transmission (motor vehicles) (See also Kraftübertragung)
wegsaugen	to suck away; remove by suction
wegwerfen	to throw away; reject
Wehr; Wehre	Defense; parapet
Wehrdienst	Military service
Wehrmacht	Armed Forces
Wehrmacht-Heer (WH)	Armed Forces, Army
Wehrmacht-Luftwaffe (WL)	Armed Forces, Air Corps
Wehrmacht-Marine (WM)	Armed Forces, Navy
Weicheisen	Soft iron
Weichlot; Weisslot	Soft solder
Weichstahl	Soft (mild) steel
Weinessig	Wine vinegar
Weingeist	Spirits of wine; ethyl alcohol
Weinsäure; Weinsteinsäure	Tartaric acid
Weinstein	Tartar
Weissglühhitze; Weissglut	White heat; incandescence
Weisskreuz	White cross (Ger marking for lacrimator)
Weisslot	See Weichlot
Weitschusspatrone	Long-range cartridge
Weitwerfer	Long-range flame thrower (See also Flammenwerfer)
Wellblech	Corrugated sheet iron
Welle	Wave; shaft; axle; frequency (Rad)
Wellenband	Wave band; frequency band (Rad)
Weltkrieg	World War I (WWI)
Wendepunkt	Turning point; critical point
werfen	to throw; fling
Werfer (W)	Launcher for rocket or signal projectile; mortar (lit Thrower)
Werfergranate (Wfgr) (See also Wurfgranate)	Mortar shell; rocket
Werferrahmen	Frame-type rocket projector
Werft	Shipyard; wharf; dock
Werg	Tow; oakum
Werk	Work; works; plant; factory
Werkstatt	Workshop
Werkstoff	Material (industrial)
Werkzeug	Tool; instrument
Werkzeugpatrone (WZ Patr)	Steel precision round used by armorers for testing the function of weapons (lit Instrument cartridge)
Werkzeugstahl	Tool steel
Wesen	Being; nature; character
Wespe	Wasp; SP Howitzer (See under Panzer in descriptive part)
Westwall	West Wall (Fortifications along Germany's western frontier)
Wetter	Weather; storm; firedamp (Mining)
Wetterdynamit	Permissible dynamite; dynamite safe to use with firedamp
Wetterkunde	Meteorology (Met)
wettersicher	safe in the presence of firedamp
Wettersprengmittel; Wettersprengstoffe	Permissible explosives; safety mining explosives; explosives safe to use in fiery coal mines
Wetzstein	Whetstone; hone
Wichte	Unit of weight; specific gravity
wider	against; contrary to
Widerstand	Resistance
Widerstandmesser	Ohmmeter
Widerstandzentrum	Center of resistance; center of drag
Widerstoss; Wiederstoss	Countershock
wieder	again; anew
Wiege	Cradle (G)
wiegen	to weigh; rock
Wimpel	Pennant
windabwärts; leewärts	downwind
Winde	Windlass; winch; worm (screw)
Windflügel	Arming vane (B)
Windflügelsicherung	Arming vane stop
Windmesser	Wind gauge; anemometer
Windschutzscheibe	Windshield
Windstreichholzer	Storm matches for lighting a fuze (lit Wind strike matches)
Windstrom	Blast current; air current
Windung	Twist (Ord)
windwärts	windward; upwind
Winkel	Angle; V-formation corner
Winkelgruppe	Firing angles
Winkelmesser	Goniometer; gunner's quadrant; protractor
Winkelspiegel	Periscope; protectoscope (Tk)
Winker	Flagman; signaler using a signal disk; signal arm or light indicating direction of turn
Winterkrieg	Winter warfare
Winterlost	50/50 mixture of Lewisite and mustard gas (CWS)

Wirbel	Vortex; eddy; spigot; drum roll
Wirbelstrom	Eddy current; whirlpool
Wirbelsturm	Cyclone; tornado
Wirbelwind	Whirlwind (20 mm SP four-barreled AA gun) (See also under Panzer in descriptive part)
wirksame Schussweite	Effective range
Wirkung	Action; effect; efficiency
Wirkungsbereich	Field of fire; sphere of action; effective range
Wirkungsgrad; Nutzeffekt	Efficiency
Wischer	Wiper; sponge; windshield wiper
Wischstock	Cleaning rod (G)
Wismut; Wismuth; Wissmut	Bismuth (Bi)
Wolfram	Tungsten; wolfram (W)
Wolfram-Nickel-Stahl	Tungsten-nickel-steel
Wolframstahl	Tungsten steel
Wolke	Cloud; wave of gas (CWS)
Wolle	Wool
Wolakuche	Boat-type runner placed under gun wheels for operation in deep snow
Wucht	Kinetic energy; striking power; force of impact
Wulst	Pad; padding; roll; enlargement
Wulst (am Geschoss)	Shoulder; swell (on projectile)
Wurf	Throw; cast; bomb release
Wurfbahn; Wurfparabel	Bomb trajectory
Würfel	Cube; pellet; die; capsule
Würfelpulver (WP)	Cubical (or prismatic) powder or propellant; dice-shaped propellant
Wurfgerät (schweres Wurfgerät) (See also Nebelwerfer)	Heavy projector for rockets, signals, etc (Chemical rocket projector)
Wurfgeschoss	Missile; projectile
Wurfgranate (Wgr) (See also Werfergranate)	Mortar shell; rocket projectile
Wurfgranatzünder (WZ)	Mortar shell fuze
Wurfkörper	Special projectile for signal pistols; rocket projectile
Wurfladung (Wurfldg)	Reduced propelling charge
Wurfmine	Trench-mortar shell or bomb
Wurfpfeil	Dart; arrow
Wurfrahmen	Framework-type projector for HE or incendiary rockets
Wurfweite	Mortar range; throwing range for hand grenades; bombing range
Würgebohrung	Tapered bore; choke barrel (Ord); (See also konisches Rohr)
Würgelpumpe	Rotary pump
Würgezange	Crimping pliers (for caps)
Würgung	Crimp (Ammo)

X

X-Strahlen	X-Rays (See also Röntgenstrahlen)
Xylol	Xylene

Y

Yperit	Mustard gas; yperite
Y-Rohr; Y-Röhre	Y-tube

Z

Zacke; Zacken	Prong; tooth; notch
Zähe; Zähigkeit	Toughness; tenacity; viscosity
Zahl	Number; numeral
Zahnarzt	Dentist
Zahnrad	Gear wheel; pinion; toothed wheel
Zahnradpumpe	Gear pump
Zange	Pliers; tongs
Zapfen	Peg; pin; plug; stud; pivot
Zapfhahn	Drain cock; tap
Zäsium; Cäsium	Cesium
~~Zehnling (Zehnlg)~~	Tee-tuber
Zeichen	Sign; mark; signal
Zeichnung	Drawing; blueprint; drawing
Zeiger	Pointer; indicator; hand; needle
Zeit	Time (length); period (See also Uhrzeit)
Zeitbombe	Time bomb
Zeitmesser	Chronometer
Zeitschnur; Zeitzündschnur	Time fuse; safety fuse; Bickford fuse; blasting fuse
Zeitschrift	Periodical; journal; magazine
Zeitung	Newspaper; paper; news
Zeitzünder (ZtZ); (ZZdr)	Time fuze (Ammo)
Zeitzündung	Delayed ignition
Zelle	Cell; cellule
Zelle	See under Vaplanz in descriptive part
Zellon	Cellulose acetate
Zellstoff	Paper pulp; cellulose
Zelluloid	Celluloid
Zellulose	Cellulose
Zellwolle	Cellulose fiber
Zementcylindrische Bombe (ZCB)	Concrete cylindrical bomb
Zementieren	Cementation
Zement-Kalk	Hydraulic lime
Zementstahl	Cementation steel
Zentner	Hundredweight; 50 kg
Zentralblatt	Central journal or paper
Zentrierwulst (Compare with Führungsband)	Bourrelet (lit Centering band)
Zentrifugalsicherung	Centrifugal safety (Fz)
Zer; Zerium	Cerium
zerbrechen	to break in pieces; shatter; crack
zerdrücken	to crush; crumple
zerfallen	to disintegrate
zerfliessen	to deliquesce; melt

zerkleinern	to reduce to small pieces
Zerkleinerungsmaschine	Crusher; pulverizer
Zerknallstoss	Blast; concussion
zerknistern	to decrepitate
zerlegen	to decompose; disassemble; dismantle
Zerlegerzünder; Zerlegungszünder	Self-destroying fuze (AA Ammo)
Zerlegung	Dispersal; self-destruction; stripping
zermahlen; zerreiben	to crush; grind fine; triturate; pulverize
zerreissen	to tear; lacerate; break
Zerschneidezünder	See Zug- und Zerschneidezünder
Zersetzung	Decomposition; disintegration
zerspalten	to split up; cleave
zersplittern	to split up; shatter; dissipate (forces etc.)
zersprengen	to crack; burst into pieces; blow up
zerspringen	to explode; burst
zerstäuben	to reduce to dust; atomize; spray
Zerstäuberdüse	Spray nozzle; Diesel fuel injector
Zerstäubegerät	Chemical spray apparatus
Zerstörer	Destroyer (Nav); long-range fighter (Avn)
Zerstörpatrone	Gun destruction charge
Zerstörung	Destruction; demolition
Zerstörungsarbeiten	Demolitions
Zerstörungsbombe	Demolition bomb
Zerstörungsfeuer	Destruction fire
Zerstreuung	Dispersion; diffusion; scattering
Zerteilung	Division; separation
Zertrennung	Separation
Zettel	Card; ticket; tag
Zeug	Ordnance supplies; gear; equipment; stuff; material; fireworks composition
Zeugamt	Ordnance Department

Note: Zeugamt was in charge of weapons, ammunition, military vehicles and clothing

Zeughaus	Arsenal; armory
Zeugnis	Certificate; transcript of grades (School)
ziehbar	ductile
ziehen	to draw; pull
Ziehen; Ziehung	Drawing
Ziehzünder	Pull firing device (LdMi)
Ziel	Goal; target; objective; aim
Zieleinrichtung	Sighting mechanism
zielen	to aim; sight
Zielfernrohr	Telescopic sight mechanism (Rf)
Zielgerät; Zielvorrichtung	Sighting mechanism; bomb sight
Zielmunition	Subcaliber ammunition; target practice ammunition
Zielpunkt	Target point; aiming point
Zielpuppe	Target dummy
Zielscheibe	Practice target
Zielschwärze	Bull's-eye
Ziffer	Figure; number; cipher
Zifferblatt	Dial (on instruments)
Zink	Zinc
Zinknebel	HC smoke mixture (Zn dust 40 and hexachloroethane 60%); Berger mixture
Zinn	Tin
Zipfel	Tip; point; end; lobe; ear
Zoll	Inch (2.54 cm); duty; tariff; toll
Zonenzeit	Standard time
Zubehör	Accessories; fittings
Zucker	Sugar
Zuckerin	Saccharin
Zufluss	Flow; flux; resources
Zuführer	Feeder; feed mechanism (automatic weapons); belt feed (MG)
Zug (pl Züge)	Train; rifling groove; pulling; draft platoon
Zugabe	Supplement; addition
Zugbrücke	Drawbridge
Zugdruckzünder	Pull-pressure igniter (LdMi)
Zugfeder	Draw spring
Zugfestigkeit; Zugspannung	Tensile strength
Zugkraft; Zugleistung	Tractive force; traction
Zugmaschine	Prime mover; tractor
Zugtau	Tow rope
Zug- und Druckzünder 29 (ZDZ 29)	Pull and push igniter 29; (lit Pull and pressure igniter) (LdMi)
Zug- und Zerschneidezünder 35 (ZuZZ 35)	Pull and tension wire igniter 35; (lit Pull and cut up igniter) (LdMi)
Zugverkehr	Railroad traffic
Zugversuch	Tensile test
Zugwagen	Tractor
Zugzünder	Pull igniter
Zugzünder 35 (ZZ 35)	Pull igniter 35 (LdMi)
zumachen	To shut; close
Zumischpulver	Admixed powder; dope (in dynamites)
Zumischstoff	Admixed material; admixture
Zündanlage	Ignition system
Zündapparat	Ignition apparatus; priming apparatus; magneto; exploder; blasting machine
zündbar	inflammable
Zündbolzen	Percussion plunger (TiFz)
Zünddraht	Priming wire
zünden	to ignite; detonate; fire a demolition charge; take fire
Zunder	Tinder; forge scale
Zünder (Zd)	Igniter (LdMi); fuze (Sh) (to set the fuze)
Zünder (elektrische)	Electrical igniter
Zünderdeckel	False ogive (Proj)
Zündereinstellung	Fuze setting
Zünderfüllmasse; Zündsatz	Fuze filling; fuze composition
Zündergehäuse	Fuze body (Sh); fuze cover (B); fuze housing
Zündergerät, tragbar	Portable demolition equipment
Zünder, gesicherter	Fuze set at safety (See also Zünder, scharfer)
Zünderhalter	Detonator holder
Zünderhülse	Hood of a fuze; fuze cover
Zünderkappe	Closing cap (TiFz); head (PD Fz); upper cap (Clockwork Fz)
Zünderkörper	Body of a fuze
Zünderlaufzeit	Time of functioning of a fuze

Zünder, scharfer	Armed fuze
Zünderschutzkappe	Fuze cap, protective
Zündersprengkapsel 43	Cap and detonator assembly 43
Zünderstellmaschine	Automatic fuze setter (in AA gun)
Zünderstellung	Fuze setting
Zünderteller	Body of a powder-train time fuse
Zündervorrichtung	Austrian name for a fuze (lit Fuze device)
Zünderzwischenstück	Fuze extension cap
zündfertig	fuzed; armed; ready for firing (Fz)
Zündgerät	Demolition equipment
Zündgerät 40, tragbar	Portable demolition kit pattern 40
Zündholz; Zündhölzchen (Schwedisches Zündhölzchen)	Match (Safety match; Swedish match)
Zündhülse 502	Primer tube 502 (French design)
Zündhütchen (Zdh)	Primer (SA Ammo); percussion primer (Fz); percussion cap (Ammo); propellant primer (Ammo)
Zündhütchenhülse	Casing of a primer; primer cup
Zündhütchensatz	Priming composition
Zündhütchenzange	Primer pliers
Zündkanal	Primer vent (Cart); axial flash hole (Fz); cap hole (BlCart); vent hole (obturator)
Zündkapsel	Detonator
Zündkegel	Anvil (in primer cap)
Zündkerze	Spark plug
Zündkirsche	Ignition pellet
Zündladung (Zdldg; Zdlg)	Booster charge; gaine; ignition tube
Zündladung, A, B, C/98, C/98Np; 36 and 40	See under Booster in descriptive part
Zündladung No. 4	Ignition tube used in smoke generators and smoke grenades
Zündladungskapsel	Detonator casing (Fz); primer container; primer charge housing
Zündladungskörper	Detonator charge (Fz); primer composition
Zündloch	Touch hole; vent hole; flash hole
Zündmagnet	Ignition magneto
Zündmaschine (See also Glühzündapparat)	Blasting machine; exploder (Engr)
Zündmasse	Ignition mixture; igniting composition
Zündmetall	Flammable metal (such as Mg, Al or Zr)
Zündmittel	Igniter and fuse materials
Zündmittelkasten Satz A,B,C	Fuses and accessories, types A,B,C
Zündnadel	Percussion needle; firing pin (Fz)
Zündnadelgewehr	Needle gun (invented in 1836 by N. von Dreyse)
Zündpapier	Ignition paper
Zündpatrone	Ignition cartridge; percussion tube
Zündpille	Pellet of a detonating composition in a cap
Zündpulver	Priming powder
Zündpunkt	Flash point
Zündreiz; Initialimpuls	Initial impulse
Zündröhrchen	Vent; channel to transmit fire
Zündsatz	Powder train (Ammo or Dem); igniter train (Pyro); fuze composition
Zündschnur (Zdschn) (See also Zeitschnur)	Safety fuse; lanyard; match cord
Zündschnuranzünder 29A, 29B, 29C	Safety fuse lighter or igniter, type 29A, 29B, 29C
Zündschnur, detonierend	Detonating fuse; primacord;
Zündschnurzeitzünder	Time fuse igniter
Zündschraube	Threaded percussion primer (for propellant)
Zündschrauben Futter	Bushing of a threaded percussion primer
Zündschrauben Hülse	Case of a threaded percussion primer
Zündstift	Firing pin
Zündstoff	Flammable material; igniting agent
Zündstrahl	Flash in an igniter or primer
Zündübertragung	Induced detonation (Dem)
Zündung (Zdg)	Firing; detonation (Ammo and Dem); ignition
Zündungstemperatur	Temperature of ignition
Zündverstärker	Reinforcing igniter (See in descriptive section)
Zündverbindung (Zdv)	Relay (Fz)
Zündverteiler	Distributor (Mot)
Zündvorrichtung	Priming arrangement; igniting mechanism
Zündwaren	Flammable goods
Zündwärme	Heat of ignition
zunehmender Drall	increasing twist; progressive rifling
Zuneigung	Inclination; attachment
Zunge	Tongue; pointer; needle (of a balance)
Zurrbolzen	Locking pin (G)
Zurrung	Locking mechanism (G or MG); seizing; anchorage
Zurückgleiten	Recoil
Zurückstossung	Repulsion; pushing back
Zusammenfassung	Summary; resumé; concentration (Arty)
zusammengefasstes Feuer	Concentrated fire (Arty); collective fire (SA)
Zusammensetzung	Composition; synthesis; chemical compound
Zusammenstoss	Collision; encounter; clash
Zusammenwirken	Synchronization; coordination; working together
Zusammenziehung	Contraction; shrinking
Zusatz (Zus)	Addition; admixture; appendix; extension
Zusatzgetriebe	Auxiliary transmission; auxiliary drive
Zusatzkartusche	Additional (secondary) propellent charge
Zusatzladung	Additional charge; augmenting charge (Mor); increment (in SL Ammo)
Zusatzmittel	Addition agent; reagent
Zusatzstoff	Admixed material; material for admixing
Zuschlag	Addition; increase; extra charge; admixture
Zustand	State; condition; situation
Zustellung	Delivery
Zutritt	Access; admittance; admission
Zuwachs	Increase; increment; growth

zweiachsig	biaxial
zweiäugig	binocular
Zweibein	Bipod (MG)
Zweidecker	Biplane
Zweielektrodenröhre	Diode tube (Rad)
Zweigleitung; Zweiglinie	Branch line (RR); junction line
Zweimetall	Bimetal
zweimotorig	twin-engine
Zwei-Ohr-Verfahren	Binaural method (sound location)
zweiphasig	two-phase; biphase
Zweipolröhre	See Zweielektrodenröhre
Zweirad	Bicycle
Zweitaktmotor	Two-cycle engine
zweiwertig	bivalent; divalent
Zwickzange	Cutting pliers; pincers
Zwilling (Zw)	Twin; two-tuber
Zwillingsgestell; Zwillingslafette	Twin mount (Ord)
Zwillingsläufe	Twin barrels (such as in MG)
Zwillingsmaschinengewehr	Twin-barreled MG
Zwillings-MG-Drehturm	Revolving turret with twin-barreled MG
Zwillingssalz	Double salt
Zwillingswaffe	Twin-barreled weapon
Zwinge	Cramp; clamp; vise
Zwinger	Wedge
Zwirn	Thread (linen)
Zwirnband	Tape
Zwirnfadenbund	Binding thread
zwischen	between; among
Zwischenbodengeschoss	Large caliber shell provided inside with a solid partition
Zwischenlage	Intermediate layer
Zwischenprodukt	Intermediate product
Zwischenstück	Adapter
Zwischenstufe	Intermediate stage
Zwischenzeit	Time interval
Zwischenzustand	Intermediate state
Zyanwasserstoffsäure	Hydrocyanic acid; prussic acid (CWS)
Zylinderpulver (Zylp)	Cylindrical propellant
Zylinderverschluss	Bolt mechanism (Rf)

Abbreviations
(American and British)
Used in the Preceding Vocabulary and in the List of German Abbreviations which Follows

AA Antiaircraft; AAG Antiaircraft gun; AC Aircraft A/C Anticoncrete; A/D Antidisturbance; Am Ammonium; Ammo Ammunition; Ap Airplane; AP Armor-piercing; A/P Antipersonnel; A/T Antitank; Avn Aviation; B Bomb; Ball Ballistics; BC Ballistic cap; BD Fz Base detonating fuze; Bl Blasting; C Cap or capped; Cart Cartridge; Cavy Cavalry; contg containing; CP Concrete-piercing; Cryst Crystal or crystalline; CWA Chemical Warfare Agent; CWS Chemical Warfare Service; DA Direct action; DEGDN Diethyleneglycol dinitrate; Dem Demolition; E-Boat Enemy boat (British designation for German PT-Boat); Elec Electrical; Engr Engineers; Expl Explosive(s); Fix Ammo Fixed ammunition; Fix G Fixed gun; Fort Fortification; Fz Fuze; G Gun; Ger German; Govt Government; GP General purpose; GP-HE General purpose-high explosive; Gr Grenade; Guny Gunnery; H or How Howitzer; HdGr Hand grenade; HE High explosive; HEAT High-explosive, antitank; HoC Hollow charge; shaped charge; Imp Impact; Inc Incendiary; Inc B Incendiary bomb; Inc-T Incendiary-Tracer; Infy Infantry; kc kilocycle; kg kilogram; km kilometer; L A Lead Azide; LD Long delay; LdMi Land mine; lit literally; L St Lead styphnate; Math Mathematical; Mc Megacycle; Mech Mechanical; Met Meteorological; M F Mercuric fulminate; MG Machine gun; Mi Mine (land or underwater); Mk Mark; Mor Mortar; Mot Motor; Mount Mounting; N Nose; Nav Naval; NC Nitrocellulose; NCO Noncomissioned officer; NG Nitroglycerin; NGc Nitroglycol; NGu Nitroguanidine; Ord Ordnance; PD Fz Point-detonating fuze; PETN Pentaerythritol Tetranitrate; Pist Pistol; pl plural; Proj Projectile; Pyro Pyrotechnical; QF Quick firing; Rad Radio; Rf Rifle; Rock Rocket; RR Railroad; Railway; SA Small arms; SA Ammo Small arms ammunition; SAP Semi-armor-piercing; Sgt Sergeant; Sh Shell; Shr Shrapnel; S L Ammo Separate-loaded ammunition; SP Self-propelled; SP G Self-propelled gun; SP How Self-propelled howitzer; T or Tk Tank; Td Torpedo; Tech Technical; Teleg Telegraph; TiFz Time fuze; Tr or T Tracer; Traj Trajectory; Wp Weapon; Wt Weight

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LIST OF GERMAN ABBREVIATIONS (Abkürzungen) OF ORDNANCE AND RELATED TERMS

(In collaboration with K. F. Kempf of Aberdeen Proving Ground, Maryland)

A

A; Abw	Abwehr	Defense
A; Art	Artillerie	Artillery
A(when following projectile designation; white stencilling)	Ausstossladung	Expelling charge of a shrapnel or smoke projectile
A(such as in: Hl/A, Hl/B, Hl/C)	Hohlladung A, B, and C	Types of hollow charges
A-1	Aggregat Eins	Aggregate No 1
Note: A-1 was the first successful liquid-propellent rocket developed at the Rocket Development Center at Kummersdorf West		
A-4	Aggregat Vier	Aggregate No 4
Note: A-4, commonly known as V-2, was one of the most successful liquid-propellent rockets (See V-2 in the description section)		
aA; AA	alte Art	of old type or pattern (See also nA and aF)
AB	Abwurfbehälter	Aerial bomb container
Examples: AB 23 SD2; AB 24 SD 2, AB 36, AB 42, AB 500-1B, AB 500-3A, etc [TM 9-1985-2(1953), pp 95-108 and 11-119]		
AB (black stencilling on a projectile, such as KGr rot AB)	Ausstossbüchse (Kanonengranate rot AB)	Smoke canister ejected from projectile on burst (Gun shell with red smoke canister)
Abk	Abkürzung	Abbreviation
Abpr; Abr	Abpraller	Ricochet; ricochet burst
Abr	Abrüstung	Demobilization; disarmament
Abs	Absender	Sender
absol	absolut	absolute
Absch Ger	Abschussgerät	Grenade launcher
ABSt	Artillerie-Beobachtungsstelle	Artillery Observation post
Abt; Abtlg	Abteilung	Section; detachment; department
Abw	Abwehr	Defence
Abz	Abzug	Trigger; retreat
ac	anni currentis	of the current year
ACB (such as in WGR AT ACB)	(Wurfgranatenzünder Trolitul ACB)	Marking on a plastic PDFz in 80 mm smoke mortar shell [TM 9-1985-3(1953), p 591]
a/d	an der	on the; at the
aD	ausser Dienst	retired
adD	auf dem Dienstwege	Through official sources; through channels
AD	Armeedolch	Army dagger
Adj	Adjutant	Adjutant
Adm	Admiral	Admiral
ADO	Allgemeine Dienstordnung	General Service Regulations
Adr	Adresse	Address
Ae; Ä	Aether; Äther	Ether
AEG	See under Varplants (descriptive section)	
aeW; äW	aeussere (äussere) Weite	Outside diameter
Afl	Artillerieflieger	Artillery air observer; Artillery spotting flier
A G	Atomgewicht	Atomic weight
A-G	Aktiengesellschaft	Joint Stock Company; Open Corporation
AGFA; Agfa	A-G für Anilinfarbenfabrikation	Aniline Dye Manufacturing Corporation
AGs	Anschiessgeschoss	Sighting projectile
AHA	Allgemeines Heeresamt	General Army Office
AHQ	Armeehauptquartier	Army Headquarters
AK	Armeekorps	Army Corps
akt	aktiv	active; on duty
Al	Aluminium	Aluminum
Al (black stencilling following the designation of shell 7.5 cm GebGr 15 Al)	Aluminiumgriess	Designation of an HE shell containing some granular Al flash producer

ALF	See under Varplants, etc (descriptive section)	
Alk	Alkohol	Alcohol; ethyl alcohol; ethanol
Am	America; amerikanisch	America; American (See also VStA)
Am	Ammonsalpeter	Ammonium nitrate
AmmonStrP	Ammonstreifenpulver	Am nitrate strip propellant
a/M	am Main	on the Main (river)
am	an dem	at; by; to; on; near to
AML	Armee-Munitionslager	Army Ammunition Depot
AmpSt	Amperestunde	Ampere-hour
amtl	amtlich	official
An	Anisol	Trinitroanisole (TNAns)
An 60/40	Anisol 60/40	TNAns 60 and Am nitrate 40%
Anf	Anfang	Beginning
AnfGeschw	Anfangsgeschwindigkeit	Initial velocity; muzzle velocity
Angew Chem	Angewandte Chemie (formerly Zeitschrift für Angewandte Chemie)	Applied Chemistry (Journal)
Anh	Anhang	Appendix; supplement
Anh	Anhänger	Trailer; supporter; follower
AnhW	Anhängewagen	Trailer
Anl	Anlage	Plant; establishment
Anm; Anmerk	Anmerkung	Remark; footnote
Ann	Annahme	Acceptance; receipt
Ann	Annalen der Chemie	Annals of Chemistry (Journal)
Anp	Anpassung	Adaptation
ANR	Armee Nachrichten Regiment	Army Signal Regiment
ansch	anschiessen	to hit by shooting
Ansch Patr	Anschiesspatrone	Ammo used for adjustment fire
Anst	Anstalt	Establishment; institution
Anz	Anzahl	Number
Anz	Anzeiger	Indicator; informer
ANZ	Anzünder	Igniter
ANZ-29	Anzünder 29	Friction pull type igniter used to ignite a safety fuse or to set off a smoke candle (TM 9-1985-2, pp 286-7)
AO	Artillerieoffizier	Artillery officer
Ao	Ago	Designation of airplanes manufd by Ago Co
AP	Artilleriepunkt	Artillery reference point (Gunnery)
App	Apparat	Apparatus; device; equipment
AR	Artillerieregiment	Artillery regiment
Ar; AR	Arado	Designation of airplanes manufd by Arado Co
ARDR	Meaning unknown to us	Designation of a smoke signal flare (TM 9-1985-2, p 80, Fig 84)
A/R	am Rhein	on the Rhine (river)
Ark	Arktikmunition	Ammo for use in Arctic climate
Arm	Armee	Army (formation above Army Corps)
arm	armiert	Armed
Ars; As	Arsenal	Arsenal
Ars	Arsenik	Arsenic (As)
Art; Artl; A	Artillerie	Artillery
Art SchPl	Artillerieschiessplatz	Artillery firing range; Proving ground
AS	Anforderungssignal	Call signal
ASt	Auswertestelle	Computing station (sound and flash ranging gunnery)
At; Atm	Atmosphäre	Atmosphere
Att	Attaché	Attaché
Attr	Attrape	Dummy
Atü	Atmosphärenüberdruck	Gage pressure; pressure above atmospheric
Aubo	Aussenbordmotor	Outboard motor
Aufb	Aufbau	Building up; construction; organization
Aufl	Auflage	Edition
Aufn	Aufnahme	Photographic picture
Auftr	Auftreff	Impact (gunnery)
Ausb	Ausbeute	Yield
Ausb	Ausbildung	Training
Ausbr	Ausbrennung	Erosion (of a barrel)
Ausf	Ausführung	Execution; completion; model; design
Ausg	Ausgabe	Issue; issuance
Ausr	Ausrüstung	Arms and equipment

autom Gew	automatisches Gewehr	Automatic rifle
AVA	See under Warplants, etc (descriptive section)	
AW	Abwehrwerfer	Defense smoke shell mortar
aZ	auf Zeit	Temporary
AZ	Azetylzahl	Acetyl number
AZ; Az	Aufschlagzünder	Percussion fuze; PDFz
AZf Hbgr	AZ fur Haubengranate	PDFz for shells with ballistic cap
AZflWM	AZ für leichte Wurfmine	PDFz for light mortar shell
AZfmExMR	AZ für mittlere Exerziermine, Rauch	PDFz for medium practice mine, with smoke
AZ 39K	Aufschlagzünder 39, Klappensicherung	PD fuze, pattern 39 with centrifugal safety device
AZmK	AZ mit Kappe	Capped percussion fuze
AZmV	AZ mit Verzögerung	Delay action percussion fuze
AZmVfKGrmP	AZ mit Verzögerung für Kanonengranate mit Panzerkopf	Delay PDFz for cannon shell with armored head
AZoV	AZ ohne Verzögerung	Nondelay percussion fuze
AZ 269 oV mStö(f)	Aufschlagzünder ohne Verzögerung mit Stössel (französisch)	French impact fuze without delay with tappet (hammer)
AZ 38 St	Aufschlagzünder 38, Stahl	Steel PD fuze, pattern 38
AZuBZ	Aufschlagzünder und Brennzünder	Time and percussion fuze (TPFz) (lit Impact and burning fuze)
AZ 23 umg	AZ 23 umgeändert mit zwei Verzögerungen	PDFz 23, modified, with two delays
AZ 23v (0.15)	AZ 23 vereinfacht mit 0.15 Sekunden Verzögerung	PDFz 23, simplified, with 0.15 seconds delay
AZ 23 Zn	Aufschlagzünder 23, Zink	Zinc PD fuze, pattern 23

B

B; Bet; Batts	Batterie	Battery
B	Bau	Construction
(b)	belgisch	Belgian (Marking on equipment)
B	Beutel	Bag; pouch
B	Bombe	Bomb
B; Bu	Buchse	Jack; bushing; socket (Rad)
B; Bü	Büchse	Rifle; canister; shot gun; tin can
B1E, B1EZA and B1EZB	Bombe 1E, etc	Types of 1 kg Inc bombs (TM 9-1985-2, p 48)
B1.3E, B1.3EZA and B1.3EZB	Bombe 1,3E, etc	Types of 1.3 kg Inc bombs (TM 9-1985-2, p 49)
B2EZ and B2.2EZ	Bombe 2EZ, etc	Types of 2 kg and 2.2 kg Inc bombs (TM 9-1985-2, p 49)
BA	Bauamt	Building and construction office
Baj	Bajonett	Bayonet
BAK; BallAK	Ballon Abwehr Kanone	AA gun (lit Balloon defense gun)
Ball	Ballistik	Ballistics
Ball	Ballon	Balloon
Baon; Batl	Bataillon	Battalion
bas	basisch	basic
BASF	See under Warplants (Descriptive section)	
B-B (such as SC 250-B)	B-Bombe (Sprengcylindrische 250)	HE cylindrical bomb of three-piece construction; nose-cast steel, body-tube steel and base-arched case steel (TM 9-1985-2, p 8)
Bb; Beob	Beobachtungsbatterie	Observation battery
BD	Bleidraht	Lead wire; decoppering wire or foil
Bd	Boden	Base; bottom
Bd	Brand	Fire; incendiary
BDC	————	Designation of a cluster-bomb container (TM9-1985-2, pp 93-5)
BdG; Bd Gesch	Brandgeschoss	Incendiary projectile
BdGr	Brandgranate	Incendiary shell
BdZ	Bodenzünder	Base detonating fuze (BDFz)
BdZd 3.7 cm Pzgr	Bodenzünder der 3.7 cm Panzergranate	PDFz of 37 mm AP shell
BE	Besondere Einflüsse	Special factors (Ball)
Be; Bet	Beton	Concrete
Fefh	Befehlshaber	Commanding officer
BeGr; Betgr	Betongranate	Concrete-piercing shell (See also GrBe)
beh; behelfsm	behelfsmässig	emergency; hasty; improvised; makeshift
BdStz (such as in DOV BdStz 15)	Bodenstütze (DOV Bodenstütze 15)	Base support Meaning of DOV is unknown to us.

Beil	Beilage	Annex; enclosure; appendix
Beilldg	Beiladung	Increment charge; booster charge
beim	bei dem	at; near; about; with
Beiw	Beiwagen	Side car
Bel	Belagerung	Siege
Bel	Belastung	Load; charge; burden
Ber	Berichte (der Deutschen Chemischen Gesellschaft)	Reports of the German Chemical Society (Title of a journal). Called now "Chemische Berichte"
ber; beritt	beritten	Mounted
Berl	Berlin	Berlin
Bes	Besatzung	Garrison; crew
Besch	Beschiessung	Firing; shelling; bombardment
besp	bespannt	horse-driven
Bet	See Be	
Bet; Betr	Betriebs	operational
BetGr; Betgr	See BeGr and GrBe	
Bett; Bet	Bettung	Base (fixed gun); foundation (gun emplacement); platform (RR gun)
Bett Gesch	Bettungsgeschütz	Outrigger base gun (AA); gun on platform mounting
Beutelkart (such as in French 10.5 cm shell)	Beutelkartusche	Propellent charge in a bag
Bew	Bewaffnung	Arms
Bez; Bz	Bezirk	District
bezw; bzw	beziehungsweise	respectively; or; and/or
Bf; Bhf	Bahnhof	RR station
Bfh	Befehlshaber	Commanding officer (CO)
BGesch	Beobachtunggeschoss	Projectile used for adjustment fire
Bgw	Bergwerk	Mine
BhrGesch	See Bo; BoGesch	
BhrPatr; BohrPatr	Bohrpatrone	Demolition cartridge; blasting cartridge
BhrPatr 88	Bohrpatrone 88	Demolition cartridge 1888 (containing picric acid)
BhrPatr 02	Bohrpatrone 02	Demolition cartridge 1902 (contg 75 g of TNT)
BhrPatr 28	Bohrpatrone 28	Demolition cartridge 1928 (contg 100 g of TNT)
BhSkL	Behelfssockellafette	Auxiliary pedestal mount
Bi (such as SC 50 Bi)	———— (Sprengcylindrische 50 Bi)(Bombe)	HE cylindrical bomb having a one piece cast steel body machined down (TM 9-1985-2, p6)
BK 1	Blendkörper 1	Frangible smoke grenade; glass smoke grenade, pattern 1
BK	Bordkanone	Aircraft or shipboard cannon
BK (such as Mk 250 BK)	———— (Mark 25 BK)	Marking on a container with 25 modified red flares and three SD 2 bombs (TM 9-1985-2, p 108)
BL	Bordlafette	Gun mount on ship or airplane
Bl (black or white stencilling)	Blau	used in conjunction with Deut to indicate blue color of smoke
Bl; BlK	Blaukreuz	Blue cross (Ger marking on sternutators)(CWS)
Bl	Bleiplombe	Lead seal of protective cap (fuze)
Bl (white stencilling)	Blindgeladen; Blindgeschoss	Ammo with inert charge
BLC (such as 50 kg BLC)	Blitzlichtcylindrische (Bombe)	Photoflash cylindrical bomb, 50 kg (TM 9-1985-2, p 81)
blf	blätterförmig	in leaflets or flakes
BLM	See under Warplanes (descriptive section)	
BlP	Blättchenpulver	Propellant in the form of square flakes (Used in some howitzers)
BlWaff	blanke Waffen	Armes blanches (bayonet and other cutting weapons)
BMW	See under Warplants (descriptive section)	
Bn-Stoff	Brommethyläthylketon	Bromomethylethyl ketone (tear gas) (stable)
Bo; BoGesch	Bohrgeschoss	APHE projectile (HE charge exploded after the armor or concrete was pierced
Bo; BoPr (black stencilling)	Bohrgeschoss, Pressstahlform (ausgebohrte Pressstahlgranate)	Forged steel shell with cavity filled with HE
Bo (1 inch lettering midway between the rotating band and shoulder)	————	Indicates a rotating band of the bimetal type, iron covered with copper (TM 9-1985-3, p 349)
Bola	Bodenlafette	Ventral gun mount
Bo Stg (black stencilling)	Bohrgeschoss, Stahlgranate	Light case shell of cast steel (TM 9-1985-3, p 349)
B Patr	Beobachtungsgeschoss Patrone	Fixed round with a smoke producing projectile used for adjustment fire
Br; Bd	Brand	Fire; incendiary

Br (such as Br C 250 A)	Brandbombe	Incendiary bomb (TM 9-1985-2, p 55)
Br (white stencilling)	Brandgranate	Incendiary shell
BR	See Bustr	
BrG; BrGesch	Brandgeschoss	Incendiary bullet
Brgr; BrGr	Brandgranate	Incendiary shell
Brgr m L'spur	Brandgranate mit Leuchtspur	Incendiary shell with tracer
Brgr o L'spur	Brandgranate ohne Leuchtspur	Incendiary shell without tracer
BrK	Bruno Kanone	Railroad gun
Brldg	Brandladung	Incendiary charge (in a projectile or a bomb)
BrMrs	Bronze Mörser	Bronze mortar
BrNK	Bruno N Kanone	Bruno railroad gun
Brpzgr	Brandpanzergranate	Armor-piercing-incendiary projectile
BrSatz	Brandsatz	Incendiary composition in a projectile or bomb
BrSchrGrPatr	Brandschrapnell Granate Patrone	Incendiary shrapnel shell
BrSpgr; Brspgr	Brandsprenggranate	High-explosive-incendiary projectile
BrSprgrPatr L'spur m Zerl (such in 15 mm MG-151)	Brand Sprenggranate Patrone mit Zerlegung	HE-incendiary-tracer, self-destroying fixed round of ammo
BrZ; BZ; Bz	Brennzünder	Time fuze (lit Burning fuze)
Bs	Beschuss	Firing; shooting
BsPatr	Beschusspatrone	Proof round (high pressure round)
BSB (such as BSB-360, BSB-700 and BSB-1000)	———————	Various types of incendiary bomb containers [See in TM 9-1985-2 (1953), pp 110-11]
BSK (such as BSK-36)	———————	Rectangular, aluminum bomb container [See in TM 9-1985-2 p 98]
BSt	Beobachtungsstelle	Observation post
BStbMi	B-Stabmine	Concealed stick mine (TM 9-1985-2, p 276)
B-Stoff	Bromaceton	Bromacetone (tear gas) (unstable) (CWS)
BSW	See under Warplants (descriptive section)	
BT	Bombentorpedo	Torpedo bomb
BtsK	Bootskanone	Boat assault gun
Bu	See B; Bu	
Bu	Buntrauch	Colored smoke
Bü	Bücker	Designation of airplanes manufd by Bücker Co
Bu	See B; Bu	
Bull (Belg)	Bulletin de la Societé Chimique de Belgique	Bulletin of the Belgian Chemical Society (Journal)
Bull (Fr)	Bulletin de la Societé Chimique de France	Bulletin of the French Chemical Society (Journal)
Bustr; BR (black stencilling)	Buntrauchsprengladung	Filling in a projectile giving on burst a cloud of vari-colored smoke (See also Buntkreuzmunition)
BV	Benzolverband	Association of manufacturers of benzene
BZ; Bz; BrZ	Brennzünder	Time fuze (lit Burning fuze)
BZ-24; BZ-39	Brennzünder 24; Brennzünder 39	Friction, pull type igniters used in hand grenades (TM 9-1985-2, pp 283-4)
Bz	Benzol	Benzene
BZA	Bombenzielapparat	Bomb sight
BZE	Brennzünder E	Friction, pull type igniter used in "egg" type grenade (TM 9-1985-2, p 284)
BZG	Bombenzielgerät	Bomb sight
bzgl	bezüglich	referring to; in reference to
Bzn	Benzin	Gasoline
bzw	See bezw	

C

C (such as C/1, C/2 . . . C/12 etc)	Construktion (obsolete spelling of Konstruktion)	Model; type; make (when placed after designation of a gun, shell, fuze, etc)
C (such as SC 1000-C "Hermann")	——————— (Sprengcylindrische 1000 C)	Marking on a 1000 kg HE cylindrical bomb (See in TM 9-1985-2, pp 9-10)
C; CZ; ChZtr Ca	See ChZtr circa (zirca)	about; approximately
C-Gesch	C-Geschoss	Streamlined projectile
Chl	Chloroform	Chloroform
Chm	Chemie	Chemistry
Ch-mZ; cMZ	Chemisch-mechanischer Zünder	Chemical-mechanical igniter
ChZtr; CZ; C	Chemisches Zentralblatt	German journal similar to Chemical Abstracts
CMZ 41	Chemisch-mechanischer Zünder 41	Chemical-mechanical type igniter, pattern 41

CMZ-41W	Chemisch-mechanischer Zünder 41W	Chemical-mechanical igniter for delayed action demolition (TM 9-1985-2, p 313)
CPVA	See under Warplants, etc (descriptive section)	
Cu (white stencilling)	Kupfer	Copper driving band
C-Zug	Zugmaschine für schwerste Artillerie	Prime mover for heavy artillery

D

D; Dpf	Dampfer	Steamer
D	Dauerfeuer	Continuous fire
(d)	deutsch	German (marking on equipment)
D	Dichte S	Specific gravity; density
D	See Digl	
D; Dm	Durchmesser	Diameter
D (in fuze designation Hbgr Z 55D)	——————— (Haubengranatenzünder 55D)	Rocket nose fuze under BC, (See in TM 9-1985-3, p 585)
D (in igniter designation, DZ 35)	Druck (Druckzünder 35)	Pressure type igniter (TM 9-1985-2, pp 295-6
DA (in fuze designations, such as DAAZ)	Direkte Aktion (Direkte Aktion Aufschlagzünder)	Designates a direct action fuze, such as DA Impact Fuze (TM 9-1985-3, pp 552, 555, 556, 561)
D A -G	Dynamit Aktiengesellschaft	Dynamite Joint Stock Co
(dän)	dänisch	Danish (marking on equipment)
Dap	Dapolin	Trademark of motor fuel
DB; DF	Dreibein; Dreifuss	Tripod
DD-Gesch; DdGesch	Dumdumgeschoss	Dumdum bullet
Dep	Depesche	Telegram
Deut (Gesch); Dt	Deutgeschoss	Projectile giving on burst a cloud of colored smoke serving as indicator
Deut (Patr)	Deutpatrone	Indicator cartridge, such as for grenade pistol
DF	See DB	
DPS	See under Warplants (descriptive section)	
Di	Dinitrobenzol	Dinitrobenzene (DNB)
Digl	Diglykolnitrat	Diethyleneglycoldinitrate (DEGDN)
Digl; DiglP; D	Diglykolpulver	Double-base propellant DEGDN-NC, stabilized with centralite, with K sulfate added to reduce flash
Digl BlP	Diglykol Blättchenpulver	DEGDN-NC (double base) square flake propellant
DiglP	See Digl	
DiglPV	Diglykolpulver, verbessert	DEGDN-NC, improved propellant
Digl RGP	Diglykol Ringpulver	DEGDN-NC (double-base) propellant(a circular disc with a central hole)
Digl RP	Diglykol Röhrenpulver	DEGDN-NC (double base) tubular propellant
Digl StrP	Diglykol Streifenpulver	DEGDN-NC (double base) strip propellant
DIN	Deutsche Industrie Normen	German industrial standards
DL	Doppellafette	Two-barreled mount
DLH	Deutsche Lufthansa	Designation of a German commercial air line
DM ; Adamsit	Diphenylaminchlorarsin	Adamsite (CWS)
Do	Dornier	Designation of airplanes manufd by Dornier Co
DO (such as in 15 cm DO Ger 38	——————— 15 cm DO Gerät 38	Marking on 150 mm smoke shell mortar 38
DOP [such as in DOP 15 Wu (Digl)]	———————	Marking on a DEGDN propellant used in mortar ammo (Recognition Handbook for German Ammunition Sup Hqs AEF, April 1945, p 201)
DopZ; DoppZ; DZ	Doppelzünder	Combination fuze; time and percussion fuze (TPFz)
DoppZ mK	Doppelzünder mit Klappen sicherung	TPFz with folding safety device
DoppZ nF	Doppelzünder neue Fertigung	TPFz, new construction
DoppZ S/60	Doppelzünder, Sekunden 60	TPFz, 60 seconds burning time
DoppZ S/60 Fl	Doppelzünder Sekunden 60, Fliehkraftantrieb	TPFz, 60 seconds burning time, centrifugally operated
DoppZ S/60 Geb	Doppelzünder, Sekunden 60, Gebirgsgeschütz	TPFz 60 seconds for mountain gun
DoppZ S/60s	Doppelzünder, Sekunden 60, schwere	TPFz, 60 seconds, heavy
DOV (in fuze designation such as BdZ DOV)	——————— (Bodenzünder DOV)	Marking on a base-detonating fuze used in 150 mm rocket projectile (TM 9-1985-3, p 622)
DOV (in booster designation DOV Zdlg C/98Np	——————— DOV Zündladung, Construktion 98, Nipolit)	Marking on the PETN booster, pattern 98 used in 150 mm smoke rocket 41 (15 cm Wurfgranate 41Nb)

DPG	See under Warplants (descriptive section)	
Dr	Doctor	
DR	Deutsches Reich	German State
DR	See Digl RP	
DRP	Deutsches Reichspatent	German State Patent
DRP angem	Deutsches Reichspatent angemeldet	German State Patent applied for
D/See (such as in NC 50 D/See	———— (50 kg Nebelcylindrische Bombe D/See)	Marking on 50 kg Cylindrical Smoke Bomb, Floating (TM 9-1985-2, p 59)
DST; DSt	See Digl StP	
St (Gesch)	See Deut (Gesch)	
Du	Duplex	Duplex
Dü	Düse	Nozzle; jet; injector; vent (rocket)
DüW	Düsenwaffe	Jet weapon such as Panzerfaust) (lit Vent weapon)
DV	See DiglPV	
DVA	See under Warplants (descriptive section)	
DVA	See under Warplants (descriptive section)	
DWM	See under Warplants (descriptive section)	
Dyn	Dynamit	Dynamite
DZ	See DoppZ	
DZ	Druckzünder	Pressure type igniter
DZ 35(A)	Druckzünder 35(A)	Pressure igniter used in heavy A/T mine and some prepared charges (TM 9-1985-2, p 295)
DZ 35 (B)	Druckzünder 35(B)	Pressure igniter used in booby traps and some prepared charges (TM 9-1985-2, p 296)
DZG	Deckungszielgerät	Protected (sheltered) optical aiming device

E

E	Einfeuer	Single shot fire
(E) (when marked on projectiles or weapons)	Eisenbahn	Railway; railroad
E; El	Elektrisch	electric
E	Elektron	Electron
E	Elektron	An alloy of Mg and Al used as an incendiary (See also ET)
E; e	empfindlich	sensitive
(e)	englisch	English (marking on equipment)
E	Entfernung	Range; distance
E (such as in BZE)	———— (BrennzünderE)	Marking on a friction, pull-type igniter (TM 9-1985-2, p 284)
E-4	Enzian-4	Air-to-air weapon called "Great Enzian" (TM 9-1985-2, p 229)
EAZ	Empfindlicher Aufschlagzünder	Superquick impact fuze
Ec	————	With rear driving band only
E-Flak	Eisenbahn-Flugzeugabwehrkanone	RR antiaircraft gun
EHZ	Empfindlicher Haubitzzünder	Sensitive howitzer fuze; graze fuze
Ei (black stencilling)	Einschiessgeschoss	Projectile used for adjustment fire; see ranging shell
Eihgr	Eierhandgranate	Egg shaped hand grenade
EinlLf; El	Einlegelauf	Sub-caliber barrel
EinlR	Einlegerohr	Sub-caliber barrel; liner
EisMi	See FlEsMi	
EKZ; EKz; EKzdr	Eisenbahnkopfzünder	PDFz of shell with ballistic caps used in RR guns
EKZ	empfindlicher Kanonenzünder	Sensitive cannon fuze; graze gun fuze
EKz; EKZ; EKZdr	empfindlicher Kopfzünder	Sensitive type of PDFz
El; E	electrisch	electric
EL	Erdkampflafette	Ground mount
EL	Ersatz Lafette	Replacement gun mount
E-Latte	Entfernungslatte	Aiming post
ElAZ; elAZ	Elektrischer Aufschlagzünder	Electric impact fuze
elRDZ	See ERZ; ERDZ	
ElZ; elZ	Elektrischer Zünder	Electric fuze
ElZZ; elZZ	elektrischer Zeitzünder	Electric time fuze
Em; EMG	Entfernungsmessgerät	Range finder
EMK	Elektromotorischekraft	Electromotive force (EMF)
EMP	Erma-Maschinenpistole	Erma automatic pistol
ENZ; ena (in fuze designation Mk 35 ENZ 3/40)	———— (Mark 35 ENZ 3/40)	Marking on a Czech PD fuze used in German 47 mm shell (TM 9-1985-3, p 568)

EP	Einheitspulver	Standard propellant (See descriptive part)
EP	See ErsRP	
EPGL'sp	Exerzierpatrone Granate mit Leuchtspur	Drill cartridge with tracer projectile
EPS	Effektive Pferdestärke	Actual horsepower
Er; Erstp	Erstarrungspunkt	Solidification point
ERDZ	See ERZ; ERDZ	
Ers	Ersatz	Substitute; replacement; spare part
ErsRP; EP	Ersatzröhrenpulver	Substitute, tubular propellant
Ersst; ESt	Ersatzstück	Substitute piece; inert item resembling in appearance a fuze, found in front section of some projectiles
ERZ; ERDZ	Elektrischer Randdüsenzünder	Electric rimvent fuze (Ammo)
ERZ 39	Elektrischer Raketenzünder 39	Electric igniter for rocket propellant, pattern 39 (TM 9-1985-3, p 623)
Es	Einschiessgeschoss	Registering projectile; adjustment fire projectile
EsMi	See FlEsMi	
ESMiZ-40	Elektrischer S-Minenzünder	Electric pressure igniter used in S-Mine
ESN	Einzelsternpatrone	Single star cartridge
ESt	See Ersst	
ET	Elektron-Thermit	Incendiary missile made of Elektron (Mg-Al alloy) and filled with thermite (Al-Fe oxide)
EV	Eingetragener Verein	Chartered Society; Registered Company
Ex (red stencilling)	Exerziergeschoss	Drill ammunition; practice ammunition
ExB	Exerzierbombe	Practice bomb
ExMu	Exerziermunition	Drill ammunition
ExPatr	Exerzierpatrone	Drill cartridge
EXRZ f lWM	Exerzierrauchzünder für leichte Wurfmine	Practice smoke fuze for mortar mine
EZ	empfindlicher Zünder	Instantaneous fuze; superquick fuze (lit Sensitive fuze)
EZ	Entlastungszünder	Antilifting igniter (with HE charge)
EZ	Esterzahl	Ester number
EZ-44	Empfindlicher Zünder, pattern 44	Antilifting and antiremoval device (release or pressure type) placed beneath land mines (TM 9-1985-2, p 518)

F

F; Fahr	Fahrenheit	Fahrenheit
F; FS	Fallschirm	Parachute
F; Fd	Feld	Field (of battle)
F (black stencilling)	Fernladung	Indicated a shell to be fired only with super charge of propellant
F (in projectile designation such as FHGr F)	Ferngeschoss (Feldhaubitzegranate Ferngeschoss)	Long range shell or propellant (for a field howitzer)
F (such as in DoppZ nF)	Fertigung (Doppelzünder neue Fertigung)	Construction (Time-percussion fuze, new construction)
F	Fliehbolzen	Centrifugal safety pin
F; Fl	See Fl; F and also Fg	
F; Flzg	See Flzg	
F (in FZ)	See FZ	
(f)	französisch	French (marking on equipment)
f	für	for
F-25 / F-55	Feuerlilie 25 / Feuerlilie 55	Fire lilly 25 and 55, rocket-propelled guided missiles (TM 9-1985-2, pp 223-6)
FA; FdA; Fda; Felda	Feldartillerie	Field artillery
FA (such as in flare MkC 50 FA)	Fallschirmleuchtbombe (Mark C 50 FA)	Part of designation of single candle parachute flare described in TM 9-1985-2 p 71
Fab; Fabr; Fbr	Fabrik	Factory; plant
F & L	Franken und Lunenschloss	Makers of Dreyse carbine
FAZ	Fernladung Aufschlagzünder	Long distance impact fuze
FB	Führungsband	Driving band (in shell)
FB (such as in flare: FB 50)	Fallschirmleuchtbombe (FB 50)	Mark on a single candle parachute flare described in TM 9-1985-2, p 67
Fb; Flieb	Fliehbolzen	Centrifugal belt (fuze safety device)
Fd	See F; Fd	
FdA	See FA	
FDO	Felddienstordnung	Field Service Regulation
Fdw	See Fldw	
Fe; Fernspr	Fernsprecher	Telephone
Febe; FE	Feldeisenbahn	Light narrow gage RR

Feka	Fernkampfartillerie	Long-range artillery
Felda	See FA	
FeldaG	Feldartilleriegerät	Field artillery equipment
Feldg; Feldgend	Feldgendarm; Feldgendarmerie	Military policeman; military police
Feldw	See Fldw	
FEP	See under Warplants, etc in descriptive part	
Fepo	Feldpolizei	Field police
Fernf	Fernfeuer	Long-range fire
Fesh	Fernsehen	Television
FES (white stencilling, such as in 10.5 cm FHGr 38 FES)	Führungsring, Sintereisen (10.5 cm Feldhaubitzgranate 38 FES)	Sintered iron rotating band (such as in 105 mm field howitzer shell 38 FES)
FessB	Fesselballon	Captive balloon; sausage balloon
Fest	Festung	Fortification; fortress; fort
Festkr	Festungskrieg	Siege warfare
Feu	Feuer	Fire
Feuerw	Feuerwaffen	Firearms
Feuerw	Feuerwerker	Ordnance sergeant
FEW (white stencilling such as in 15.2 cm Sprgr FEW)	Führungsring, Weicheisen (15.2 cm Sprenggranate FEW)	Soft iron rotating band (in 152 mm HE shell)
FF	Festungsflak	Fortress AA gun; stationary AA gun
FF	Flugzeugflügel	Wing of an airplane
FF (MK)	(Maschinenkanone) im Flügel eines Flugzeug	Rapid fire cannon in the wing of an airplane
FFA	See under Warplants, etc (descriptive section)	
FFM (such as 2 cm MG FFM)	———— (2 cm Maschinengewehr FFM)	Marking on a 20 mm AC machine gun
Fg, Fgst	Fahrgestell	Chassis
FG; FGesch	Feldgeschütz	Field piece; field gun
FG; FGew; FSJG-42	Fallschirmjäger Gewehr-42	Paratroop fully automatic rifle
Fg; Fl; Flg	Fliehgewichtsantrieb	Operated by centrifugal force (Fz)
(AZ Zerl Fg)	(Aufschlagzünder, Zerleger, Fliehgewichtsantrieb)	PD fuze, self-destroying, centrifugal (TM 9-1985-3, p 546)
(ZtZ S/30 Fg)	Zeitzünder, Sekunden 30, Fliehgewichtsantreib	Mechanical time PD fuze in which the motive power was derived from centrifugal force; 30 seconds delay (TM 9-1985-3, p 597)
FGesch	Ferngeschoss	Long range projectile
FsW-43	Festungswerfer 43	Fortress mortar; fixed mortar
FGZ	See under Warplants, etc (descriptive section)	
FH	Feldhaubitze	Field howitzer
FHGr Nb	Feldhaubitzgranate Nebel	Field howitzer smoke shell
FHGr Stg	Feldhaubitzgranate, Stahlring	Field howitzer shell, steel ring
FHSchr	Feldhaubitzschrapnell	Field howitzer shrapnel
Fhz	Fahrzeug	Vehicle
Fi	Fieseler	Designation of airplanes manufactured by Fieseler Co
FK	Federkapsel	Cap over a spring
FK	Feldkanone	Field cannon
Fk	Funk	Radio
FKFS	See under Warplants (descriptive section)	
Fl; Flg	Flagge	Flag
Fl; F (such as in DoppZ S/60 Fl)	Fliehkraftzünder; Fliehgewichtsantrieb (Doppelzünder, Sekunden 60, Fliehgewichtsantrieb	Centrifugally operated fuze (Time-percussion fuze, 60 seconds burning time, centrifugal)
Fla	Flugzeugabwehr	AA defense
Flachf	Flachfeuer	Flat trajectory fire
FlaDrMG	Fliegerabwehr-Dreifachmaschinengewehr	AA triple machine gun
Flak	Flugzeugabwehrkanone	AA cannon; AA gun
Flakvierling 38 (2 cm)	2 cm Flugabwehr-Vierling	20 mm Four-barreled AA gun
Flam	Flugabwehrmaschinenwaffen	Automatic AA weapons
Flam (B) (such as: C-250)	Flammenöl Bombe	Incendiary bomb filled with flammable oil
FlDü	Flügeldüse	Jet motor mounted on a wing
FlDrSt	Fliegerdrehstütze	Meaning unknown to us
Fldw; Feldw; Fdw; Fw	Feldwebel	Master Sergeant
FlEisMi; FlEsMi; EsMi (FlEisMi 42)	Flascheneismine; Eismine (Flascheneismine 42)	Glass bottle antipersonnel land mine (Glass bottle A/P mine 42)

FlEsMi	See FlEis Mi	
FlEsMiZ	Flascheneisminen Zünder	Pressure igniter for A/P glass bottle mine (TM 9-1985-2, p 307)
FLeucht	Fallschirmleuchtpatrone	Parachute-flare signal cartridge
FlM; FlMi	Flügelmine	Fin-stabilized mortar projectile
FlMW	Flügelminenwerfer	Trench-mortar firing finned projectiles
FlTMi 41; FlTrMi 41	Flusstreibmine 41	River drifting (floating) mine, pattern 41
Flugb	Flugboot	Flying boat
Flugzg; Flzg; Flz	Flugzeug	Airplane
FlW; FmW	Flammenwerfer	Flame thrower
FM	Feldmarschall	Field marshall
FMG	Fernmessgerät	Range finder
FMG	Flugzeugabwehrmaschinengewehr	Rapid-fire AA machine gun
FmW	See FlW	
FoFü	See under Warplants (descriptive section)	
Fp	Füllpulver	Filler; filling explosive; bursting charge
Fp02	Füllpulver 02	1902 pattern filling (TNT)
Fp 5	Füllpulver 5	TNT contg 5% wax
Fp 88	Füllpulver 88	1888 pattern filling (Cast P A)
Fp 60/40	Füllpulver 60/40	60/40 filling (TNT 60 and Am nitrate 40%)
Fp C/02	Füllpulver C/02	Same as Fp 02
FPatr	Feldpatrone	Field gun cartridge (fixed ammunition)
Frw	Feuerwerker	Artificer; ordnance sergeant
FS; Fschm	Fallschirm	Parachute
FSchr	Feld-Schrapnell	Field gun shrapnel
Fsp	Fernsprecher	Telephone
Fst; Fs	Festung	Fortress; fort; fortification
FSt; FuSt; FS	Funkstelle; Funkenstation	Radio station
F-Stoff	Titantetrachlorid	Titanium tetrachloride (smoke producing agent)
FSTr	Fallschirmtruppen	Parachute troops
Fu	Funk; Funker	Radio; radio operator
FuMG	Funkmessgerät	Radar
FuSt	See FSt	
FuTr	Funktrupp	Signal Corps detachment
FuTu	Funkturm	Radio sending tower
Fvtg; Fvtl; Fvt	Feuerverteilung	Fire distribution
Fw	See Fldw	
FW; Fw	Focke-Wulf	Designation of airplanes built by Focke-Wulf Co
FZ (such as FZ 60)	———— (F Zünder 60)	Marking on a clockwork aerial burst fuze (See in TM 9-1985-2, p 186)

G

G	Gas	Gas
G; Ger	Gerät	Equipment; apparatus; device
G; Gesch	See Gs	
G; Gesch	Geschütz	Gun; cannon
G; Gew	Gewehr	Rifle
G; g	Gramm	Gram
G; Gr	Granate	Shell; grenade
G (propelling charge stencilling)	Pulvermasse G (Gallwitz)	Propellant with a standard heat of explosion (690 kcal/
G 98; Gew 98	Gewehr 1898	Rifle, model 1898
Gamma-Mrs	Gamma Mörser	420 mm Heavy mortar
Gbd; Geb	Gebäude	Building
Gbb	Güterbahnhof	Freight yard
GB; GBomb	Gasbombe	Chemical bomb
GDrH	Gasdruckhülse	High-pressure cartridge
Geb; Gb	Gebirg	Mountain
Geb (in fuze designation AZ 23 Geb)	Gebirgs- (Aufschlagzünder 23 Gebirgsgeschütz)	Mountain- (PD fuze 23 for mountain ordnance)
GebG; GebGesch	Gebirgsgeschütz	Mountain gun
GebGr	Gebirgsgranate	Shell for mountain gun
GebH; GebHaub	Gebirgshaubitze	Mountain howitzer; pack howitzer
GebIG; GebJG	Gebirgsinfanteriegeschütz; Gebirgsjägergeschütz	Mountain infantry gun; or howitzer
GebK	Gebirgskanone	Mountain cannon

Gef	Gefreiter	Acting corporal; private first class
GebLdg	Geballteladung	Concentrated charge consisting of several explosive blocks tied together; prepared charge
GebLdg 3kg	Geballteladung	Prepared TNT charge, 3kg
geh	geheim	secret
gel; Gel	geladen	loaded
Gel; GelK	Gelbkreuz	Yellow cross (Ger marking on vesicants)(CWS)
gel	geliefert	delivered
GemPol	Gemeindepolizei	Township police; local police
Gen	General	General
GenStbH	Generalstab des Heeres	Army General Staff
gep; gp	gepanzert	armored
Ger; G	Gerät	Equipment
Gesch; G	Geschoss	Projectile; missile
Gesch; G	Geschütz	Piece; gun; cannon
GeschGiess	Geschützgiesserei	Gun foundry
Gestapo	Geheime Staatspolizei	Secret state police
Gew; Gwr; G	Gewehr	Rifle
GewGr; Gg	Gewehrgranate	Rifle grenade
GewGrGew	Gewehrgranatengewehr	Grenade rifle
GewSprgr	Gewehrsprenggranate	HE rifle grenade
gez	gezogen	rifled
Gf	Geschossfabrik	Shell factory
Gf; GeschFabr	Geschützfabrik	Gun factory
GFM	Generalfeldmarschal	Field marshal
Gg	Geschossgewicht	Weight of projectile
Gg	See GewGr	
Gg; Gr	Grauguss	Cast iron
GgP; GewGrPz	Gewehrgranate Panzer	A/T rifle grenade
GGr; Ggr	Gasgranate	Gas grenade
GH	See GebH	
GK	See GebK	
GKart	Gewehrkartusche	Cartridge case
GKF	gepanzerte Kampffahrzeuge	Armored combat vehicle
GKw	Geschützkraftwagen	Self-propelled gun mount
GL	Gauleiter	District leader
gl	glatt	smooth; even
Gl; Glst	Gleichstrom	Direct current
Gldg	Gewichtladung	Weight of live projectile
Gleisk	Gleiskettenfahrzeug	Full-track vehicle
GleiskPz	Gleisketten-Panzerfahrzeug	Full-track armored vehicle
glGesch	Glattes Geschütz	Smooth-bore gun
GL'spur; Gl'spur	Glimmleuchtspur; Glimmspur	Tracer with glowing composition dim tracer
Glühz	Glühzünder	Low tension electrical igniter
glWM	glatte Wurfmine	Smooth bore mine-thrower shell
Gm	Gasmaske	Gas mask
GM	Generalmajor	Major General
GmbH	Gesellschaft mit beschränkter Haftung	Company with limited liability; limited company
GMi	Geschossmine	Mine made from a shell
Go	Gotha	Designation of airplanes built by Gothaer Waggonfabrik
gp	gepanzert	armored
GP; G Pulver	Gallwitz Pulver	DEGDN propellant developed in 1930's by General Uto Gallwitz (See "G" Pulver in descriptive section)
Gr; G	Granate (See also Sprgr)	Grenade; shell; projectile
gr	grau	gray
Gr	Grenze	Frontier
gr; Gr	Gross	large
gr	grün	green
GrB (such as GrB 39 & GrB 43)	Granatbüchse	Antitank grenade rifle
GrBe	Granate Beton	Anticoncrete shell
grBlP	grobes Blättchenpulver	Propellant in large flakes
GRweiGr	Gewehr Reichsweite Granate	Long-range rifle grenade
Grf	Granatfüllung	Shell filling; bursting charge of a projectile
Grf 88	Granatfüllung 88	Shell filler, pattern 1888 (picric acid)
Grf 02	Granatfüllung 02	Shell filler pattern 1902 (TNT)
Grkz	Grünkreuz	Green cross (CWS)

grLdg	grosse Ladung	Large charge
Grof	grosser Flammenwerfer	Heavy flame-thrower (on two-wheel carrier)
GrPatr (See also Sprgr Patr)	Granate Patrone	Fixed ammunition HE shell
Grundldg	Grundladung	Main charge; base charge
GrW	Granatwerfer	A/T grenade rifle; grenade projector; mortar
GrW 5ling	Granatwerferfünfling	Five-barreled automatic mortar
GrZ	Granatzünder	Fuze for HE shell
grZdlg	grosse Zündladung	Large igniting charge; large primer
Gs; G; Gesch	Geschoss	Projectile
Gu; Gup	Gudolpulver	Double base DEGDN-NG, low calorific value, propellant containing about 30% Gudol (nitroguanidine)
GuBlp	Gudolblättchenpulver	Gu propellant in the form of square flakes
GuRP	Gudolröhrenpulver	Gu tubular propellant
GwFSLtGr	Gewehr Fallschirm Leuchtgranate	Illuminating parachute rifle grenade (TM 9-1985-2, p 339)
GwGrGer	Gewehrgranategerät	Rifle grenade equipment
Gwr	See Gew	
GwrGr	See GewGr	
GwrSprgr	See GewSprgr	

H

H; Hb; Hbe	See Hb	
H; Haub	Haubitze	Howitzer
H; Hptm	Hauptmann	Captain
H	Heer	Army
"h, "H"	gehärtet	hardened
H	Hexogen	RDX
(h)	holländisch	Dutch (mark on equipment)
H5; H10; H15 etc	Hexogen 5, etc	RDX + 5, etc per cent wax
H 15; Hldg 15 (H 50 + Fp02 50%)	Hohladung 15	Hollow charge containing 15 kg 50/50-RDX/TNT mixture
HA	Hexogen-Aluminium	RDX-Al explosive
HA-41	Hexogen-Aluminium 41	RDX-Al explosive pattern 41
Ha	Hamburg	Designation of airplanes built by Blohm & Voss Co, Hamburg
Haf; Hfn	Hafen	Port; harbor
Haft; HaftHldg	Hafthohlladung	Magnetic antitank hollow charge
Haft H3	Hafthohlladung, Hexogen 3kg	Magnetic HoC, 3kg RDX
Halbpzgr	Halbpanzergranate	SAP projectile (literally Half armor-piercing)
Haube	See Hb; Hbe	
Hauptkart; HptKart	Hauptkartusche	Main propelling charge in non-fixed ammunition
Hb; Hbe; Haube	Haube	Ballistic cap (false cap or windshield) on some larger caliber shells (TM 9-1985-3, p 491)
Hbf; Hbhf	Hauptbahnhof	Main depot; main RR station
Hbgr; HbGr	Haubengranate	Shell with ballistic cap (BC)
HbgrZ	Haubegranatenzünder	PDFz for use under BC
HbSchr	Haubenschrapnell	Schrapnel with BC
Hdb	Handbuch	Handbook; manual
Hdfw	Handfeuerwaffe	Small fire arms
HdGr	See Hgr	
Hdgr	Handgriff	Handle
HDP or V-3	Hochdruckpumpe	See in descriptive section
He	Heinkel	Designation of airplanes built by Heinkel Co
HF	Hochfrequenz	High frequency (Rad)
Hf	Heeresfahrzeug	Army vehicle
HFlak	Heeresflugabwehrkanone	Army AA gun
HFu	Heeres-Funkstelle	Army radio station
Hgr; HdGr	Handgranate	Hand grenade
HGr	Haubitzgranate	Howitzer shell
HGrZ; HbgrZ	Haubitzegranatenzünder	Fuze for howitzer shells
HGs	Holzgeschoss	Wooden shell (dummy)
HK (black stencilling)	Hartkern	Tungsten core (lit Hard core)
HK; HKart; HülsKart	Hülsenkartusche	Cartridge (in non-fixed ammo) as opposed to bag
HL	Hängelafette	Suspended gun mount
Hl (black stencilling); HL; Hldg	Hohlladung	Hollow charge (HoC) such as A/T projectiles; shaped charge
Hl/A; Hl/B & Hl/C	Hohlladungen A, B and C	Types of hollow charges (See TM 9-1985-3, pp 407, 411, and 313)

HLB	Hohlladungsbombe	HoC bomb
Hldg 12.5 kg	Hohlladung 12.5 kg	Prepared HoC, 12.5 kg TNT
Hldg 50 kg	Hohlladung 50 kg	Prepared HoC, 50 kg, in two parts
HMA	Heeresmunitionsanstalt	Office of Army Ammunition
HMi	Holzmine	Wooden mine
HML	Heeresmunitionslager	Army Ammunition Depot
HP	Horchposten	Listening post
Hpt	Haupt	Chief, principal
Hpt; Hptst	Hauptstadt	Capital
HptKart; HauptKart	Hauptkartusche	Main propellant charge in ammunition other than fixed
Hpt L[illegible]	Hauptladung	Base charge of blasting cap of detonator (lit main charge)
Hptm	Hauptmann	Captain
Hptwm	Hauptwachtmeister	First sergeant (Arty or Cavy)
HPzgr	Halbpanzergranate	SAP projectile
HRg	Halbring	Retaining ring
HRgP	Haubitz-Ringpulver	Propellant in rings for light field howitzer
Hs	Henschel	Designation of airplanes and guided missiles built by Henschel Co
Hschr	Haubitz-Schrapnell	Howitzer shrapnel
HT	Haubitze-in-Turm	Turret howitzer (See also leHT)
HTA	Hexogen-Trotyl-Aluminium	RDX-TNT-Al explosive mixture
HülsKart	See HK; HKart, etc	
Hut (such as in AZC (Hut)*3)	(Aufschlagzünder C(Hut)* 3)	Marking on a mechanical impact bomb fuze type 3
HWA; HWaA	Heereswaffenamt	Army Ordnance Office (Branch of the OKH)
HWZ	See under Warplants (descriptive section)	
HZgA	Heereszeugamt	Army, Ordnance and quartermaster department

I

i	im; in; ins	in; in the
I; Inf	Infanterie	Infantry
I; Ing	Ingenieur	Engineer
(I)	italienisch	Italian (marking on equipment)
IdA	Inspecteur der Artillerie	Inspector of Artillery
IG; IGesch	Infanteriegeschütz	Infantry piece; infantry howitzer
I G	Interessengemeinschaft	Association for Furtherance of Mutual Interest; Trust
IGFarben	Interessengemeinschaft Farbenindustrie	Dye Industry Trust
IGesch	See IG; IGesch	
IGK	Infanteriegeschütz Kompanie	Infantry howitzer company
Igr	Infanteriegranate	Shell for infantry piece
IgrZ	Infanteriegranate-Zünder	Infantry shell fuze
iHL	in Haubitz-Lafette	on howitzer mount; on howitzer carriage
iJ	im Jahre	in the year
iKL; iKasLaf	in Kasematten-Lafette	in casemate mount
iKstLaf	in Küsten-Lafette	in coast defense mount
iL	in Ladestreifen	in clips
iMrsLaf	in Mörser-Lafette	in mortar mount
iPL; iPzLaf	in Panzer-Lafette	in shielded mount
iRL; iRLaf	in Rad-Lafette	on wheeled carriage
iSL; iSLaf	in Schirm-Lafette	On carriage with overhead shield
IZ; Iz	Innenzünder	Internal fuze

J

J; Jäg; Jgr	Jäger	Ranger; rifleman in light infantry; pursuit plane
J	Jagdflugzeug	Pursuit plane
J	Jahr	Year
j	jährlich	yearly
j	jüdisch	Jewish
(j)	jugoslawisch	Yugoslavian (marking on equipment)
J (in bomb designation SC 50 J)	(Sprengcylindrische Bombe 50 J)	Marking on a 50 kg HE cylindrical bomb having one-piece nose and body (TM 9-1985-2, p 8)
J/2 (in bomb designation SC 50 J/2)	(Sprengcylindrische Bombe 50 J/2)	Marking on a 50 kg HE cylindrical bomb having drawn steel body and pressed steel nose (TM 9-1985-2, p8)

Ja (in bomb designation SC 50 Ja)	(Sprengcylindrische Bombe 50 Ja)	Marking on a 50 kg HE cylindrical bomb having one piece drawn steel body (TM 9-1985-2, p 6)
Jabo	Jagdbomber	Pursuit bomber
Jäg	See J; Jäg; Jgr	
(jap)	japanisch	Japanese (marking on equipment)
JB (in bomb designation Sc 50 JB)	(Sprengcylindrische Bombe 50 JB)	Marking on a 50 kg HE cylindrical bomb, an improved version of J (TM 9-1985-2, p 8)
JC (in bomb designation SC 50 JC)	(Sprengcylindrische Bombe 50 JC)	Marking on a HE cylindrical bomb having drawn steel body and pressed steel nose (TM 9-1985-2, p 8)
JF (such as JF-504)	(J-Feder 504)	Marking on a clockwork long-delay igniter (TM 9-1985-2, p 309)
JG; JGesch	Jägergeschütz	Light infantry piece (gun or howitzer)
JgdPz (PzJäg)	Jagdpanzer (Panzerjäger)	(Tank destroyer; tank hunter (See under Panzer in the descriptive part)
Jgr	See J; Jäg	
Jgr; JGr	Jägergranate	Light infantry gun projectile
JgrZ	Jägergranatzünder	Percussion fuze for use with light infantry gun projectiles
Ju	Junkers	Designation of airplanes built by Junkers Co

K

K	Kalium	Potassium
K; Kan	Kanone	Cannon
K; Kar; Kb	Karabiner	Carbine
K; Kt	Kartätsche	Case shot; canister
K (such as 3.7 cm Pak K)	(3.7 cm Panzerabwehrkanone-Kasematte)	Casemate (37 mm A/T Cannon, Fixed Defense)
K	Kasten	Box; case; magazine
K	Kern	Core
K	Krieg	War
K (in fuze designation Dopp Z 28K)	Kanone (Doppel Zünder 28 Kanone)	Time and percussion fuze, pattern 28 for use with high velocity gun (TM 9-1985-3, p 603)
K; Kast	Kasten	Box
K (in fuze designation mVuK)	Klappensicherung (mit Verzögerung und Klappensicherung)	Folding safety device (Fuze equipped with delay action and folding safety device) (TM 9-1985-3, p 580)
K (in bomb designation Sc 250-K)	(Sprengcylindrische 250-K)	Marking on a HE cylindrical bomb of three piece construction (TM 9-1985-2, p 8)
K3	Kanone 3	240 mm Gun with range up to 30 km
K5	Kanone 5	280 mm Gun with range up to 50 km
K12	Kanone 12	211 mm Gun with range up to 120 km
K18	Kanonen 18	105 mm and 150 mm Guns, pattern 1918
K 18/40	Kanone 18/40	105 mm Gun pattern 1918/1940
K; kl	klein	small
KA	Küstenartillerie	Coast artillery
Kal	Kaliber	Caliber
Kar 98k	Karabiner 98 kurz	Carbine pattern 1898, short (length of barrel 600 mm)
Kart	Kartätsche	Case shot; canister shot
Kart (Compare with Patr)	Kartusche	Cartouche; container of propellent charge not used in fixed ammunition
Kartb	Kartuschbeutel	Propellent bag
Kartd	Kartuschdeckel	Cover for Kartusche (q v)
Kart ein	Kartusche, einfach	Bag container of propelling charge placed in Kartuschenhülse (q v)
Karth; KartH	Kartuschenhülse	Cartridge case for Kartusches
Kartm	Kartuschenmunition	Ammunition using Kartuschen (Compare with Patronenmunition)
Kartvorl	Kartuschenvorlage	Muzzle-flash reducing wad
Kat	Kaltklebekitt	Cold adhesive putty used for attaching demolition charges
Kb	See K; Kar	
KBett	Kanone in Bettung	Platform mounted cannon
KC (Bombe)	Kampfstoffcylindrische (Bombe)	Chemical cylindrical, thin-walled bomb; gas bomb
KC Flam (Bombe)	Kampfcylindrische Flammenöl Bombe	Chemical cylindrical incendiary bomb (TM 9-1985-2, pp 52-3)
KDF	Kraft durch Freude	Association for welfare of workers (lit strength through joy). It financed the construction of Volkswagen and some ships

K(E)	Kanone (Eisenbahn)	Railroad gun
Kfw; Kpfw	Kampfwagen	Tank; armored vehicle
Kfz	Kraftfahrzeug	Motor vehicle
KG	Kavalleriegeschütz	Cavalry gun
KG	Abbreviation for some manufacturing company	
Kg; kg	Kilogramm	Kilogram
Kg	Kugel	Ball; sphere; bullet
Kg mB	Kilogramm mit Beutel	Kilogram including weight of bag
KGr	Kanonengranate	Cannon shell
KGr(BoPr)	Kanonen-Granate (Bohrgeschoss, Pressstahlform)	Shell prepared by drilling pressed steel block
KGrPatrPz	Kanonengranate Patronen Panzer	AP shell, fixed round
KGrRotAl	Kanonengranate, rote Sprengwolke, Aluminium	HE shell containing aluminum and giving on bursting a cloud of red smoke
KH	Kanonenhaubitze	Gun-howitzer
Kh; KH	Kammerhülse	Central burster tube in projectile
KhLdg	Kammerhülsenladung	Central burster tube charge
KiHL	Kanone in Haubitzenlafette	Gun on howitzer carriage
KiMrsL	Kanone in Mörser lafette	Gun in mortar mount
KiRL	Kanone in Radlafette	Cannon on wheeled mount
KiZ	Kippzünder	Tilt-type igniter
K-K	Kaiserlich-Königlich	Imperial-Royal (Austrian Empire)
KK	Kanone-Kasematte	Casemate gun
kl	klein	small
klK; KK	Kleinkaliber	Small caliber
K L/	Kanone, Lauflänge	Cannon of so many calibers long
(K L/50)	(Kanone, Lauflänge 50)	Cannon 50 calibers long
Kl	Klemm	Designation of airplanes built by Klemm Co
klAZ	kleiner Aufschlagzünder	Percussion fuze to fit a shell with small opening
klLdg	kleine Ladung	Small charge; reduced propelling charge
klV; Kv	kleine Verzögerung	Small delay
klZdlg (such as klZdlg 34Np)	kleine Zündladung 34	Small booster; any intermediate charge with detonator between fuze and HE filling
Kn	Knallkörper	Firecracker (simulated fire)
KN (Pulver)	Krumback Nitrat (Pulver)	DEGDN-NC propellant containing small amount of K nitrate (CIOS 31-62, p5)
KnZ	Knickzünder	Snap-type igniter
KnZdSchn	See KZS	
KOD(Pulver)	Krumbach(Pulver)ohne Nitrate aber mit Dinitrotoluol	Same as KN(Pulver) except that K nitrate was replaced by DNT (CIOS 31-62, p5)
kon	konisch	conical
KP; KdPist	Kampfpistole	Rifled Very pistol
Kp	Kappe	Cap of projectile or fuze)
Kp; Kr	See under Warplanes, etc in descriptive part	
Kpf	Kampf	Combat; battle
Kpf	Kopf	Head; nose (of a bomb); point (of a shell)
Kpfw; Kfw; Kw	Kampfwagen	Tank (lit Battle car)
KpfwAbw; KwAbw; KfwAbw	Kampfwagenabwehr	Antitank defense
KpfwAbwGesch; KwAbwG; KfwAbwG	Kampfwagenabwehrgeschütz	Antitank gun
KpfwF; KwF; KfwF	Kampfwagenfalle	Tank trap
KpfwK-Stand; KwK-Stand; Kfwk-Stand	Kampfwagenkanone-Stand	Fixed emplacement made of tank gun turret
KpfZ	See Kz; KZ; KpfZ; Kzdr	
KpfZ Zerl	See KzZerl; KpfZ Zerl	
KPS (white or red stencilling above rotating band)	Kupfer Press-stahlführungsring	Rotating band of the bimetallic type
Kr	See Krw	
Kr	Kreuz	Cross; crosspiece (of a universal joint)
Kr; KrP	Kreuzpulver	Tubular propellant with a crosspiece inside of tube
Krabus	Kraftomnibus	Motor bus
Krad	Kraftrad	Motor cycle
Krad mB	Kraftrad mit Beiwagen	Motorcycle with side car
KrG	See KrwGesch	
Kripo	Kriminalpolizei	Criminal investigation police

KrR	Kreuz Rohr	Central tube made of colloided propellant; it served to retain propellent charge in base of cartridge case (lit Cross tube)
Krw; Kr; Kw	Kraftwagen	Motor car
KrwAnh; KwAnh	Kraftwagenanhänger	Trailer truck
KrwFlak	Kraftwagen-Flugzeugabwehrkanone	Motorized AA gun
KrwG; KrGesch	Kraftwagengeschütz	Tractor drawn gun or gun mounted on a truck
KzFlak	See KzFlak	
Ks; KS	Kaskade	Cascade (cartridge similar to canister)
Kst; Küst	Küste	Coast; shore
KstA	Küstenartillerie	Coast defense artillery
KstBttr	Küstenbatterie	Coastal battery
KstG	Küstengeschütz	Coast defense gun
KstH	Küstenhaubitze	Coast defense howitzer (such as 280 mm)
KstK	Küstenkanone	Coast defense cannon
KstL	Küstenlafette	Coast defense mounting
KstMi	Küstenmine	Coastal mine
KstMrs	Küstenmörser	Coast defense mortar
Kt; KT KtPatr	Kartätsche; Kartätschenpatrone	Case shot; canister ammunition
Kt	Kanone-Turm	Turret gun
KTM (in fuze designation KTM-1)	———	Captured Russian fuzes used by the Germans in 76.2 mm projectiles
KTrMi 41	Kugeltreibmine 41	Spherical Drifting Mine, Type GL
KuTK	Kasematte-und Turmkanone	Casemate and turret gun
KV	See klV	
KVK	Kriegsverdienstkreuz	War service cross (decoration)
KVP	Kasernierte Volkspolizei	Garrisoned People's Police (Armed Forces of East Germany)
kW	Kilowatt	kilowatt
Kw	See Kpf; Kw; Kfw	
Kw	See Krw; Kr	
KWI	Kaiser Wilhelm Institut (Göttingen)	Emperor William Institute (Educational and research establishment)
KwF	See KpfwF	
KwK	See KpfwK	
KZ	Kanonenzünder	Gun percussion fuze; cannon shell fuze
Kz; KZ; KpfZ; Kzdr (in designation of amm, such as 8.8 cm SprGr L/4.5 (Kz)	Kopfzünder (8.8 cm Sprenggranate Länge 4.5, Kopfzünder) which means 88 mm HE shell, 4.5 calibers long with PDFz	Point detonating fuze (PDFz) under a ballistic cap, except in the case of the KZ-38, an ordinary PDFz (TM 9-1985-3, p 545)
kz; Kz	kurz	short
kzAzl	kurzer Aufschlagzünder	Short percussion (impact) fuze
kzBd	kurzer Bodenzünder	Short base detonating fuze
kz 28 cm BrK(E)	kurze 28 cm Bruno Kanone (Eisenbahn)	Short 280 mm Bruno Railroad Gun
KZ Boden (such as in AB 250 KZ Boden)	———	Markings on a container with 19 parachutes and three SD2 bombs (TM 9-1985-2, p 108)
KzFlak	Kraftzug-Flugzeugabwehrkanone	Motorized AA gun
Kzg [such as in sPzB 41(Kzg)]	Kraftzug [schwere Panzerbüchse 41(Kraftzug)]	Power-driven (Heavy A/T power-driven rifle)
KZGrGeb	Kanonenzünder Granate für Gebirgskanone	Gun percussion fuze for mountain gun
kzGrW	kurzer Granatenwerfer	Short barreled mortar
kzL	kurze Länge	Short length
KzL	kurze Lafette	Short gun carriage
KrLaf	Kreuzlafette	Outrigger-gun platform for AA gun (lit Cross gun mounting)
kzLK	kurze Länge-Kanone	Short-barreled gun
kzMK	kurze Marinekanone	Short Naval gun
KZS; KnZdSchn	Knallzündschnur	Detonating cord; primacord
KzZerl	Kopfzünder mit Zerleger	Self-destroying nose fuze
Kz 2Zerl P	Kopfzünder mit 2 Zerleger Pulver	Nose fuze with 2 self-destroying black powder units
KZ Zl Pv vf	Kopfzünder, Zerleger, Pulversatz, vereinfacht	Simplified self-destroying PD fuze with powder train

L

L	Ladestreifen	Ammunition clip; cartridge charge (SA)
L; Ldg; Ldg	Ladung	Charge; load; propelling charge

L; Laf; Lf (such as MG L 08/15)	Lafette (Maschinengewehr Lafette 08/15)	Gun mount; gun carriage (Machine gun mount, pattern 1908/15)
L (such as in 17 cm MrsL)	Lafette (17 cm Mörser Lafette)	Markings on a 170 mm mortar
L [such as in PzWMi 1 (L)]	Luftwaffe [Panzerwurfmine 1 (Luftwaffe)]	Air Force (A/T hand grenade 1, introduced by Air Force)
L/ (in designation of gun 8.8 cm StuK 43 L/71)	Lauf (Kaliberlänge) (8.8 cm Sturmkanone 43, Lauf 71)	Length of a gun barrel in calibers (88 mm Assault Gun pattern 43, barrel 71 calibers long)
L/ (in designation of shell 10.5 cm Sprgr L/4.4)	Kaliberlänge (Granate) (10.5 cm Sprenggranate, Länge 4.4)	Length of a shell in calibers (105 mm HE Shell, 4.4 calibers long (TM 9-1985-3, p 468
L	See Leuchtg and Lg	
L; Lfg	Lieferung	Delivery lot; shipment
l	See le; l; L	
L2 (in bomb designation, SC 250-L2, "Hermann")	———— (Sprengcylindrische 250-L2, "Hermann")	Marking on the 250 kg Cylindrical HE Bomb of two-piece construction; nose forged steel, body tube steel (TM 9-1985-2, pp 8-9)
Laf	See L; Laf; Lf	
Lag	Lager	Camp; dump; depot
LB-6t	————	Designations for hydrazine hydrate
LC	Lichtcylindrisch; Leuchtcylindrisch	Cylindrical flare; candle flare
LC-10	Lichtcylindrisch 10	Single candle parachute flare (TM 9-1985-2, p 65)
LC-50 F AusfC	Lichtcylindrisch 50 F Ausführung C	Four candle parachute flare design C (TM 9-1985-2 p 67)
LC Bombe	lichtcylindrische Bombe	Flare bomb
ld	luftdicht	airtight
Ld; Ldg	See L; Ld; Ldg	
LdgW	See LWrf	
LdKpf	Ladekopf	Charging head; a device for charging some electric bomb fuzes (TM 9-1985-2, p 132)
LdW	See LWrf; LdgW	
le; l; L	leicht	light
leFH; lFH	leichte Feldhaubitze	Light field howitzer
leG; lG; LGe	Leichtesgeschütz	Gun for airborne operations; recoilless gun
le GebIG; lGebIG	leichtes Gebirgsinfanteriegeschütz	Light gun for mountain infantry
leGeb Jg; lGebJG	leichtes Gebirgsjägergeschütz	Light gun for mountain rangers
leGrW; lGrW	leichter Granatwerfer	Light mortar
leHT; lHT	leichte Haubitze-in-Turm	Light turret howitzer
(10 cm leHT)	(10 cm leichte Haubitze-in-Turm)	100 mm Fixed Mortar (breech loading)
leIG; lIGe; leJGe; lJGe	leichtes Infanterie Geschütz	Light, very low velocity gun for use by infantry
leJgrZ	leichter Infanteriegranatzünder	Light infantry shell fuze
leLdgW; lLdgW	leichter Ladungswerfer	Light spigot mortar
leMiW; lMW	leichter Minenwerfer	Light mortar
LE-Mun	Lichteinschiess Munition	Tracer ammunition used in range adjustment fire
lePzMi; lPzMi; LPZMi	leichte Panzermine	Light AP mine; A/T mine (TM 9-1985-2, p274)
leS; lS	leichtes Spitzgeschoss	Pointed, light weight bullet
leSL'spur; lSLS	leichtes Spitzgeschoss mit Leuchtspur	Pointed light weight bullet with tracer
Leuchtg (black stencilling); L; Lg	Leuchtgeschoss	Star shell; flare shell
LeuchtgZ; LgZdr	Leuchtgeschosszünder	Time fuze for use with star shell
Leut; Lt	Leutnant	Second lieutenant (See also ObLeut)
leWMi; lWMi; LWM	leichte Wurfmine	Light mortar shell
leWMZ	leichter Wurfminenzünder	Fuze for light mortar shell
lExM	leichte Exerziermine	Light training mine
lExMmR	leichte Exerziermine mit Rauchladung	Light training mine with smoke element
LF	Lafettenfahrzeug	Gun carriage
LFA	See under Verplanes, etc in descriptive part	
lfd	luftdicht	airtight
Lfg	See L; Lfg	
lFH	See leFH	
lFK	See leFK	
LFM	See under Verplanes (descriptive [illegible])	
Lftw; Lw	Luftwaffe	Air force
Lfw	Luftfahrwesen	Aeronautics; aviation
lg	lang	long
lG	See leG	
LG (such as 7.5 cm LG 40)	Leichtgeschütz (7.5 cm Leichtgeschütz 40)	Recoilless gun (lit Light gun) (75 mm Recoilless gun, pattern 40
Lg; Leuchtg; L	Leuchtgeschoss	Flare shell; star shell

lgBdZ	langer Bodenzünder	Long base percussion fuze
lgBrlg; lB	lange Brennlänge	Long burning length (fuze)
lGebIG	See leGebIG	
lGebJG	See leGebJG	
lgFHGr(Nb)	lange Feldhaubitzgranate (Nebel)	Long field howitzer shell (smoke)
Lggr; lgGr	Langgranate	Long shell
lgKZ	langer Kanonenzünder	Long gun fuze
LgL	lange Lafette	Long gun carriage
lgM (black stencilling)	lange Mundlochbüchse	Shell with lengthened gaine-type booster
lgMB	lange Mundlochbüchse	Long gaine-type booster
LgP 40	Leuchtgeschosspulver 40	TEGDN propellant of calorific value 650 kcal/kg used with Naval starshell charges
LgP 40N	Leuchtgeschosspulver 40 (Nitronaphthalin)	TEGDN propellant of calorific value 670 kcal/kg and contg α nitronaphthalene used with Naval starshell charges
lGrW	See leGrW	
lGe	See leG	
lg sFH	lange, schwere Feldhaubitze	Long and heavy field howitzer
LGZ	See under Verplanes (descriptive section)	
LgZ; LgZdr; LeuchtgZ (such as LgZ S/33)	Leuchtgeschosszünder ————	Fuze for star shell
Lh (such as 4 cm SprgrPatr Lh 28)	Leuchtspurhülse (4 cm Sprenggranate Patrone Leuchtspurhülse 28)	Tracer container (cartridge) (40 mm HE Fixed Round with tracer cartridge type 28)
lHT	See leHT	
lJgrZ 23	Leichter Infanteriegranatzünder 23	Fuze for light infantry shell pattern 23
lIGe	See leIGe	
lJGe	See leJGe	
LK (such as Mk 250 LK)	————	Marking on a container with 41 single candle parachute flares (TM 9-1985-2, p 108)
LKZ	See lgKZ	
lLdgW	See leLdgW	
Lm; LM	Leichtmetall	Light metal (Aluminum)
Lm; LM [black stencilling such as in KZ C/27 (LM)]	Leichtmetall [Kopfzünder, Construktion 27 (Leichtmetall)]	Marking on a shell fuzed with combined cap and gaine in aluminum [Aluminum body PD fuze, Naval, pattern 1927 (TM 9-1985-3, p 565)]
LM	Luftmine	Aerial Mine
LMessg	Lichtmessung	Flash ranging
LMSt	Lichtmess-Stelle	Flash ranging station
lMW	See leMiW	
Lo (black stencilling)	losen Sprengstoffkörpern	HE filling consisting of separate explosive bodies, carton-loaded but not cemented
LP; LtPist	Leuchtpistole	Smooth bore pyrotechnic pistol such as Véry pistol; flare pistol; signal pistol
LPatr	Leuchtpatrone	Illuminating cartridge
LPist	See LP	
lPzMi; LPZMi	See lePzMi	
LrS [such as in 7.5 cm Pak 40/1 (Sf LrS) (f)]	Lorraine Schlepper [7.5 cm Pak 40/1, Selbstfahrlafette, Lorraine Schlepper (französisch)]	Lorraine tank chassis [75 mm A/T Self-Propelled Gun on Lorraine Tank Chassis (French)]
Ls (white stencilling)	Leuchtsatzsprengladung	Illuminating filler (in a shell)
Ls	Luftschutz	Air raid defense
LS	See L'spur	
LS	See leS	
Lsg	Losungswort	Password
LSGesch	See L'spurGesch	
lSLS	See leSL'spur	
[illegible]	See L'spur Mun	
[illegible]	[illegible]	Tracer element container
L'spur; L'Spur; LS; LSp	Leuchtspur; Lichtspur	Tracer projectile trajectory; trace
L'spurGesch; LSGesch	[illegible]; Lichtspurgeschoss	Projectile with tracer
L'spurMun; LSMun	Leuchtspurmunition; Lichtspurmunition	Tracer ammunition
LSR	Luftschutzraum	Air raid shelter
LT	Leuchtturm	Lighthouse
LT	Lufttorpedo	Aerial torpedo (bomb)
LuS Mun	Leucht- und Signalmunition	Flare pistol ammunition
Lux-EZ 50 BC	————	Designation of a sea [illegible] (TM 9-2985-2, p 86)

LUX N and LUXS	——	Designations of flame floats (TM 9-1985-2, p 92)
Lv	Ladungsverhältnis	Ratio of charge to weight of projectile
Lw	See Lkw	
Lwg	Lastwagen	Truck
lWM	See leWM	
lWMZ	See leWMZ	
LWrf; LdgW; Ldw	Ladungswerfer	Spigot mortar
LZzZ	Langzeitzünder	Long time delay fuse

M

M	Main	River Main
M; Man	See Man; Manöv	
M	Marine	Navy Naval
M; Mk; MK	Marke (Kennzeichen)	Mark (identification)
M	Maske	Gas mask
M; m	Meter	Meter (m)
M; Mi	Mine	Mine
M	Minengeschoss	Mortar shell; high capacity, HE missile
m	mit	with
M; Mdt; MB [such as in 8.1 cm GrWf 33 (n)]	Mündungsbremse [8.1 cm Granatwerfer mit Mündungsbremse type 33 (Norwegian)]	Muzzle brake of the Norwegian Launcher 33
(le FH18M; lFH18mM)	(leichte Feldhaubitze mit Mündungsbremse)	Light field howitzer, pattern 18 provided with muzzle brake
M	Muster	Pattern; model; sample
M-1 (Kanone)	——	Designation of a gun, cal 305 mm
MA; Ma	Munitionsanstalt	Ammunition depot; ammunition loading factory (such as at Cassel, Hannover, Ingolstadt, Juterbog, Königsberg, Stettin and Zeithain)
MAA	Marineartillerieabteilung	Naval coast artillery battalion
Mag Gew	Magazingewehr	Magazine rifle
Man; Manöv	Manöver	Maneuver
MAN	See under Warplanes (descriptive section)	
Man Kart; MKart	Manöverkartusche	Blank cartridge
Marlag	Marinelager	Prisoner-of-war camp for sailors
MB; M; Md	Mündungsbremse	Muzzle brake
MB; MlB	See Mdlchb	
M-Boot	Minensuchboot	Mine sweeper
M-Boot	Motor boot	Motorboat
Mdg	Mündung	Muzzle
Mdlch	Mundloch	Fuze hole; adapter opening
Mdlchb; MLB; Mb	Mundlochbüchse	Gaine type, fuze booster container
Mdlchf	Mundlochfutter	Gaine (lit Fuze hole casing)
Mdlchsch	Mundlochschraube	Adapter plug (Ammo)
Me	Messerschmidt	Designation of airplanes built by Messerschmidt Co
mE	mit Eisenkern	With iron core (bullet)
ME	mit Entkupferungsband	With a decoppering strip
Mebu	Maschinengewehr-Eisenbeton Unterstand	Machine gun in reinforced concrete pillbox
MEB (in rocket designation, such as 30 cm Wk 42 Spr MEB)	mit eingebauten Brennzünder (30 cm Wurfkörper 42 Spr MEB)	Markings on a 300 mm HE rocket, spin stabilized and provided with a time fuze (TM 9-1985-2, p 251)
MF	Marineform	Naval design
Mf	Motorfahrzeug	Motor vehicle
M-Flak	Flugzeugabwehrmaschinenkanone	Automatic AA gun, such as 3.7 cm M-Flak
mFmW	mittlerer Flammenwerfer	Medium-weight flame thrower
MFS	Marinefunkstelle	Naval radio station
MG; MGew	Maschinengewehr	Machine gun
mg	Milligramm	Milligram
MG08	(schweres) Maschinengewehr Konstruktion von 1908 (Maxim)	(Heavy) machine gun (Maxim) 1908 construction
MG08/15	(leichtes) Maschinengewehr, Konstruktion von 1908 mit Änderungen von 1915	(Light) machine gun, 1908 construction with changes of 1915

MGBA	See under Warplanes (descriptive section)	
M-Gerät	Mörser (auf Kraftzug)	Mortar (on motor tractor)
m ger Sprldg	mit geringerer Sprengladung	With reduced bursting charge
MGesch (such as MGesch Patr o Zerl)	Minengeschoss (Minengeschoss Patrone ohne Zerlegen)	HE, high capacity projectile (HEHC fixed round without self-destruction)
[illegible] (2 cm)	2 cm Maschinengewehr in den Flügeln eines Flugzeug	20 mm Machine gun in the wings of an airplane
MG FFM (2 cm)	2 cm Maschinengewehr FFM	20 mm Machine gun FFM
MGr; Mgr (such as 3.7 cm MgrPatr 18)	Minengranate (3.7 cm Minengranatpatrone 18)	High capacity HE shell; mine shell (3.7 mm HEHC fixed round pattern 18)
MGrW	Minengranatwerfer	Trench mortar
MGrW; mGrW	Mittlerer Granatwerfer	Medium mortar (81 mm)
mgV	mit grün Vorsignal	With green signal
mHb; mHbe	mit Haube	With ballistic cap; with windshield
MHbgr	Minenhaubengranate	HE heavy howitzer shell with ballistic cap (windshield)
Mi; Min	Mine	Mine
Mi A200	Mine A200	A/P land mine filled with 13 oz picric acid
MIAG	See under Warplanes (descriptive section)	
Milag	Militärlager	Army camp
Min-Su	Minensucher	~~Minesweeper~~
MinWf; MiW	Minenwerfer	Trench mortar
Mipo	See MP; Mipo	
Mi S 150	Mine S 150	A/P land mine containing 5½ oz picric acid
mit Ldg; mittlLdg	mittlere Ladung	Medium size charge
MiW	See MinWf	
MiWPr	See MWPr	
MiZ	Minenzünder	Mine igniter
MiZ 530(e), Mk 3	Minenzünder 530 (englisch), Mk3	Pressure type igniter for use in captured British A/T mines Mark 3 (TM 9-1985-2, p 305)
Mk	Mark	Mark; pattern
Mk	Maschinenkanone	Automatic cannon
Mk; MKb	Maschinenkarabiner	Machine carbine; submachine gun
mK	mit Kappe	With cap; capped
mK	mit Kern	With core
mK; MK (in fuze designation such as AZ 5075 MK)	mit Klappensicherung (Aufschlagzünder 5075 mit Klappensicherung	With a shutter safety device (Percussion fuze 5075 with a shutter safety device)
Mk 50 Kask	Mark 50 Kaskade	Designation of a cascade target indicating flare (TM 9-1985-2, pp 71-3)
MKA	Marine-Küstenartillerie	Naval coast artillery
MKb	See MK; MKb	
MkS	——	Designation of a two-candle sea flare (TM 9-1985-2, p 77)
Mkw	Munitionskraftwagen	Ammunition truck
mL	mit Luftvorholer	with pneumatic recuperator
MLB; Mlb; M	Mundlochbüchse	Guine-type fuze-booster container
mM; mMb	mit Mündungsbremse	With muzzle brake
MNH	See under Warplanes (descriptive section)	
mO	mit Oberzündung	With overhead ignition
Mod	Modell	Model; pattern
Mörs; Mrs	Mörser	Large caliber, short barrel howitzer, mortar
mot	motorisiert	motorized
MoTO	Monat-Tonne	Metric tons per month
MP-44	Maschinenpistole-44	Machine pistol; automatic pistol (Called later StuG-44)
mP	mit Panzerkopf	With armor-piercing cap
MP; Mipo	Militärpolizei	Military police
mPak	mittlere Panzerabwehrkanone	Medium A/T gun
MPatr	Meldepatrone	Ground illuminating, single star, signal cartridge (long range)
mPz; mP	mit Panzerkopf	With AP head
mR (black stencilling)	mit Rauchentwickler	With smoke generator
mR8	mit Rauchentwickler Nr 8	With smoke generator, type 8
mRr	mit Rohrrücklauf	With recoil
Mrs	See Mörs	
MrsL (such as in 17 cm MrsL)	Mörser L (17 cm Mörser L)	Markings on a 170 mm howitzer
MS	Mannschaftssäbel	Enlisted personnel's sword
Ms	Messing	Brass
MSGer	Minensuchgerät	Mine detector

Mstb	Masstab	Scale; standard; rule
Mstr	Muster	Pattern; model
MtlK	Mantelkanone	Jacketed gun
Mun	Munition	Ammunition
Mun; Muntrg	Munitionstraeger	Ammunition carrier
MunF	Munitionsfabrik	Ammunition factory
MunWg	Munitionswagen	Ammunition wagon; caisson
M-u R-Patr	Melde-und Rauchpatronen	Ground signal and smoke cartridges
mV; MV	mit Verzögerung	With delay action (Fz)
m verst F	mit verstärkt Fliehbolzen	With reinforced centrifugal safety bolt
mv F	mit vorderem Führungsring	With forward rotating band
mVorl	mit Vorlage	With flash reducer
MrU (21 cm)	21 cm Mörser vereinfachte Unterlafette	Simplified lower carriage for 210 mm howitzer
mVuK	mit Verzögerung und Klappensicherung	Fuse equipped with delayed action and folding safety device
MW	Minenwerfer	Trench mortar
MWA	See Marine Waffenamt in the vocabulary	
MWMZ; mWMZ	Mittlerer Wurfminen Zünder	Fuse for medium size mortar, such as 80 mm
MWPr; MiWPr	Minenwerfer-Protze	Mortar ammunition wagon; limber; caisson
mwV	mit weissem Vorsignal	With white signal

N

N	See Nb	
(n)	See (h)	
(n)	norwegisch	Norwegian (mark on equipment)
N; Ndn	Norden	North
nA; NA	neuer Art	Of new type or pattern (See also nA and nF)
Nachf	Nachfolger	Successor
Nachf	Nachforschung	Investigation; search
NAG	Nationale Automobil Gesellschaft	National Automobile Corporation
Nb; N; Neb	Nebel	Smoke; fog; gas
Nb; N(white stencilling)	Nebelgeschoss	Smoke shell
NbB Z-38	Nebelbrennzünder 38	Friction igniter, pull type; type 38, used in smoke grenade (TM 9-1985-2, p 285)
NbC	See NC	
NbGr; NbGr	Nebelgranate	Smoke shell
NbGr(Pr)	Nebelgranate (Press-stoff)	Smoke shell with plastic fuse body (TM 9-1985-3, p 607)
NbHgr	Nebelhandgranate	Smoke hand grenade
NbK; NbKz	Nebelkerze	Smoke candle; thermal smoke generator
NbKz L42	Nebelkerze, lang 42	Long thermal smoke generator 42
NbKzS	Schnellnebelkerze	Rapid thermal smoke generator
NbKzWfldg	Nebelkerzen Wurfladung	Propelling charge for thermal smoke generator
NbMun	Nebelmunition	Smoke ammunition
NbS; NS	Nebelsignal	Smoke signal
NbSt	Nebelstoff	Smoke producing material
NbSt	Nebelwurfgranate aus Stahl	Steel mortar shell
NbW	Nebelwerfer	Rocket launcher (lit Chemical smoke projector)
(15 cm NbW41)	(15 cm Nebelwerfer 41)	(150 mm Rocket launcher 41) (Six tubes)
(28/32 cm NbW41)	(28/32 cm Nebelwerfer 41)	(280/320 mm Rocket launcher 41)
(21 cm NbW 42)	(21 cm Nebelwerfer 42)	(210 mm Rocket launcher 42)
(30 cm NbW 42)	(21 cm Nebelwerfer 42)	(210 mm Rocket launcher 42)
(15 cm NbW 10 ling 42)	(15 cm Nebelwerfer-Zehnling 42)	(150 mm Ten tube rocket launcher)
(15 cm NbW 30 ling 43)	(15 cm Nebelwerfer Dreissig ling 43)	(150 mm Thirty tube rocket launcher 43)
NbZst	Nebelzerstäuber	Smoke disperser
NC; NbC(Bombe)	Nebelcylindrische (Bombe)	Smoke cylindrical (bomb)
nC	neuere Construktion	Of new type construction (See nK)
NC 250s	Nebelcylindrische 250s	Cylindrical smoke bomb filled with mixture of sulfur trioxide 60 and chlorosulfonic acid 40% (TM 9-1985-2, p 59)
NC 50 WC	Nebelcylindrische 50 WC	Floating cylindrical smoke marker bomb (TM 9-1985-2, p 59)
NC D/SEE	Nebelcylindrische D/SEE	Floating cylindrical smoke marker (TM 9-1985-2, p 59)
NdP; NP	Nudelpulver	Chopped cord propellant; nodular propellant
Neb	See Nb; N	
neb	neben	besides; next to
Neb-Ma	Nebenmunitionsanstalt	Branch ammunition depot
nF	neue Fertigung	New model
nF; NF	neuer Form	of new shape
Ng; Ngl	Nitroglycerin	Nitroglycerin

NGewP 71	neuen Gewehrpulver 71	New rifle powder 71 (used now only in igniters)
Ngl; NglP	Nitroglycerinpulver	Double-base NG-NC propellant stabilized with centralite, acardite or diphenylamine
NglBlP	Nitroglycerin-Blättchenpulver	NG-NC flake propellant
NglP	See Ngl	
NglPlP	Nitroglycerin Plattenpulver	NG-NC propellant in the form of flat discs
NGRP	Nitroglycerin Röhrenpulver	NG-NC tubular propellant
Nigu	Nitroguanidin	Nitroguanidine (NGu)
Nitroz	See Nz	
nK (formerly nC)	neuere Konstruktion (neuere Construktion)	of new-type construction
NK [in designation Bruno NK (E)]	[Bruno N Kanone (Eisenbahn)]	Markings on a 280 mm Bruno railroad gun (TM 9-1985-3, p 529)
NKz	See NbK	
NMun	See NbMun	
Np	Nitropenta	PETN (pentaerythritol tetranitrate)
NP	See NdP	
NP	Nullpunkt	Zero point; zero
Np5, Np 10, etc	Nitropenta 5, Nitropenta 10, etc	PETN + 5, PETN + 10, etc percent wax
NPatr	Nahpatrone	Low velocity ball round for close range
NpGewP	Nitropentagewehrpulver	Small arms double base propellant of PETN and NC stabilized with diphenylamine and including ethyl centralite and K sulfate
NpP	Nitropentapulver	Propellant containing PETN
Nr	Nummer	Number
NS	See NbS	
NSP; NzSP	Nitrozellulose-Schwarzpulver	Igniter powder consisting of black powder bound by colloided NC (See also under Ignition in descriptive part)
Nutzl	Nutzlast	Useful load ; pay load
NVA	See under Versplaste, etc in descriptive part	
Nz; Nitroz	Nitrozellulose	Nitrocellulose (NC)
NZ	Normalzeit	Standard time
Nz; NzP	Nitrozellulosepulver	Single base NC propellant stabilized with diphenylamine and with Na oxalate and K sulfate added to reduce flash
NzGewBlP	Nitrozellulose Gewehrblättchenpulver	NC flake propellant for rifle ammunition
NzGewP	Nitrozellulose Gewehrpulver	Small arms NC propellant stabilized with diphenylamine and including ethyl centralite and K sulfate
NzMassNdP	Nitrozellulose Massiver Nudelpulver	Porous quick burning NC, chopped cord propellant used in drill ammunition and in igniters (See also under Ignition in descriptive part)
NzNP	Nitrozellulose Nudelpulver	NC chopped cord propellant
NzP	See Nz; NzP	
NzRP	Nitrozellulose Röhrenpulver	NC tubular propellant
NzStbP	Nitrozellulose Stäbchenpulver	NC strip propellant (for pistols)
NzStP	Nitrozellulose Staubpulver	NC propellant, finely granulated

O

O; Ob; Obst	Oberst	Colonel
o	ohne	without
ot O	ortfest	fixed; permanent; static
O	Osten	East
(ö)	österreichisch	Austrian (marking on equipment)
O(black stencilling)	ohne Füllung	Without filling (marking on some inert shells)
oAl (white stencilling)	ohne Aluminium	Without aluminum (in HE shell filling)
oAz	ohne Aufschlagzündung	Fuse without percussion element
Ob	See O; Ob	
OB	Ortsbatterie	Local battery
ObBfh	Oberbefehlshaber	Commander in chief
oBD	ohne Bleidraht	Without lead wire serving as decoppering agent
Oberltn; Oblt	Oberleutnant	First lieutenant
Oberschl	Oberschlesien	Upper Silesia
Oberstlt	Oberstleutnant	Lieutenant colonel
Obfdw	Oberfeldwebel	Master sergeant (except Arty)
Obfw	Oberfeuerwerker	Ordnance sergeant; artificer
ObKrGer	Oberkriegsgericht	General Court-martial

Oblt	See Oberlt	
ObQu; ObQuMstr	Oberquartiermeister	Army quartermaster
Obst	See O; Obst	
Obus; Omn	Omnibus	Motor bus
Obwm	Oberwachtmeister	Master sergeant (Arty)
ObZm	Oberzahlmeister	Chief paymaster
oD	ohne Datum	undated
Oerl	Oerlikon	Designation of ammunition or weapons manuf by the Oerlikon Co.
Oerl Flak	Oerlikon Flugzeugabwehrkanone	Oerlikon AA gun
Offz; Offz	Offizier	Officer
Offz (W)	Offizier des Waffenwesens(Waffenoffizier)	Ordnance officer
OFK	Oberfeldkommandatur	High Field Command
oFlak; O-Flak	ortfest Flugabwehrkanone	Stationary or fixed AA gun
oH	ohne Hülse	Without a cartridge case
OKH	Oberkommando des Heeres	High Command of the Army
~~OKL~~	~~Oberkommando der Luftwaffe~~	~~High Command of the Air Forces~~
OKM	Oberkommando der Kriegsmarine	High Command of the Navy
OKW	Oberkommando der Wehrmacht	High Command of the Armed Forces
oL	ohne Ladestreifen	Without cartridge clip
oM (black stencilling)	ohne Mundlochbüchse	Shell without gaine container
oM	ohne Mündungsbremse	Without muzzle brake
oR	ohne Rauch	Smokeless
oR (black stencilling)	ohne Rauchentwickler	Shell without smoke generator
OS	Offizierssäbel	Officer's sword
oV	ohne Verzögerung	Without delay (Fz)
Oz	Ozean	Ocean

P

P; Patr	See Patr; P	
P; PG	See PG; P	
P	Phosphor	See Ph
P	Pistole	See Pist
(p)	polnisch	Polish (marking on equipment)
P; Pol; Polte	See under Werplants (descriptive section)	
P; Pv; Pulv	Pulver	Powder; propellant
P	Punkt	Point
PA	Panzerabwehr	Antitank defense

Note: Superseded in compound words by PzJag (Panzerjäger), which means tank destroyer

PAe; PA	Petroläther	Petroleum ether
Pak; PAK	Panzerabwehrkanone	Antitank gun

Note; Superseded in compound words by PzJagK (Panzerjägerkanone), which means tank destroyer gun

Pak-Flak	Panzerabwehr-und Flugabwehrkanone	Antitank-antiaircraft artillery
Patr; P	Patrone	Cartridge; round of fixed ammunition

Note: When the word "Patr" is included in a designation, such as 7.5 cm SprgrPatr, it indicates a complete round of fixed ammunition (Compare with "Kart")

Patr 318	Patrone 318	AP fixed round of ammo used in A/T rifle 39
Patr B; Patr Br	Patrone, Brand	HE-inc round of fixed ammo
PatrH	Patronenhülse	Cartridge case (of fixed ammo)
PatrKast	Patronenkasten	Cartridge box; ammunition container
Patr leS; Patr lS	Patronen leichtes Spitzgeschoss	Light, pointed ball ammunition (filled with aluminum) used for practice
Patr leS L'spur; Patr lS-L'spur	Patronen leichtes Spitzgeschoss mit Leuchtspur	Light, pointed ball ammunition with tracer; used for practice
Patr PmK	Patronen, Phosphor, mit Stahlkern	Ball ammunition, Phosphorus, with steel core
PatrS; PatrStr	Patronenstreifen	Cartridge clip
PatrS*	Patrone S*	Signified that cartridge was made of brass consisting of Cu 72 and Zn 28%
Patr SmE	Patronen Spitzgeschoss, mit Eisenkern	Pointed ball ammunition with iron core. SAP bullet
Patr SmEiSS	Patronen Spitzgeschoss mit Eisenkern für Scharfschützengeeignet	Pointed ball ammunition (SAP) for 7.92 mm sniper's rifle
Patr SmE (lg)	Patronen Spitzgeschoss mit Eisenkern (lang)	Long, pointed ball ammunition with iron core; SAP round

Patr SmK	Patronen Spitzgeschoss, mit Stahlkern	Pointed ball ammunition with steel core; AP shot
Patr SmK(H)	Patronen Spitzgeschoss mit Stahlkern (gehärtet)	Pointed ball ammunition with hardened steel core; AP shot
Patr SmKl'spur	Patronen Spitzgeschoss mit Stahlkern und Leuchtspur	Pointed ball ammunition with steel core and tracer; AP-T round
Patr sS	Patronen schweres Spitzgeschoss	Heavy, pointed ball ammunition (streamlined)
Patr sS iL	Patronen, schweres Spitzgeschoss, in Ladestreifen	Heavy, pointed ball ammunition (hard lead core), in clip
Patr St	Patrone, Stahl	Steel cartridge case
Patr St	Patrone, Stahl	Steel cartridge case
PatrTr	Patronentrommel	Cartridge drum
PC Bombe	Panzerdurchschlagcylindrische Bombe	Armor-piercing cylindrical bomb (Loading factor 15-20% HE)

[Examples: PC 1000 kg, known as "Esau" and PC 1400 kg, known as "Fritz" (TM 9-1985-2, pp 24-25)]

PC-RS Bomben (such as 500 kg and 1000 kg)	Panzerdurchschlagcylindrischen Raketenstart Bomben	Rocket-assisted cylindrical armor-piercing bombs, 500 kg and 1000 kg (TM 9-1985-2, pp 26-31)
PD Bombe (PD 500 B)	Panzerdickenwand Bombe (Panzerdickenwand Bombe 500 kg)	Armor-piercing thick-walled bomb (Loading factor 10% HE) (500 kg AP thick-walled bomb)
Pers-Stoff	Grünkreuz	"Green cross" choking gas (CWS)
Pf	Pfund	Pound
Pfd Zg	(mit) Pferdezug	Horse-drawn
Pfg; Pf	Pfennig	Pfennig (1/100 of mark)
PG (black stencilling)	Perlitguss-stahl	Shell of cast steel in the pearlite condition
PGr	See Pzgr	
Ph (black stencilling); P	Phosphor	Phosphorus incendiary filling
PH	Panzerhaubitze	Armored howitzer (self-propelled mount)
(lPH or lePH)	(leichte Panzerhaubitze)	(Light armored howitzer)
(sPH)	(schwere Panzerhaubitze)	(Medium heavy armored howitzer)
PHM 3; PzHM3	Panzerhandmine, 3kg	3 kg Magnetic mine A/T hollow charge
Pist; P	Pistole	Pistol
Pist Nahpatr	Pistolen Nahpatrone	Pistol cartridge, close range; low velocity pistol round
Pist Nahpatr 08 S	Pistolen Nahpatrone 08, Stahl	9 mm Low velocity pistol round, pattern 1908, with steel bullet
Pist Patr 08; PPatr 08	Pistolenpatrone 08	9 mm ball ammunition for pistol
PistPatr 08 mE	Pistolenpatrone 08 mit Eisenkern	9 mm pistol round with iron core bullet; SAP pistol ammunition
PistPatr 08 mSE	Pistolenpatrone 08 mit Sintereisen	9 mm pistol round with sintered iron bullet
PistPatr 08, St	Pistolenpatrone 08, Stahl	9 mm pistol round, steel case
Pivl	Pivotlafette	Pivot mounting; rotating mount (Arty)
PJ; PJäg	See PzJäg and Jgd Pz	
PJK; PJägK	See PzJägK	
PK; PKast	Pulverkasten	Ammunition box
PKpfw	See PzKpfWg	
Pkw	See PzKw	
PL [such as in PLW 42 (Sf)]	[PL Werfer 42 (Selbstfahrlafette)]	Marking on a self-propelled rocket launcher
PlP	Plättchenpulver	Multiperforated disc propellant
PlP	Plattenpulver	Propellant in the form of circular discs without a central hole (used in mortars); rolled propellant; sheet propellant
PlPatr	Platzpatrone	Blank cartridge
PlPatrGer	Platzpatronengerät	See Vocabulary
PM; Pulvmag	Pulvermagazin	Powder magazine; ammunition magazine
P mK; Ph mK	Phosphorgeschoss mit Stahlkern	AP-Inc bullet with phosphorus and a steel core
P-Mun; Pl-Mun	Platzpatronenmunition	Blank ammunition
PoL; Pol; POL	Pulver ohne Lösungsmittel	Solventless propellant (propellant produced without the use of a solvent)
Pom	Pommern	Pomerania
PP	Polizeipistole	Police pistol (such as Walther)
PPatr 08	See PistPatr 08	
PPK	Polizeipistole, Kriminal	Criminal detectives pistol (such as Walther)
Pr	Pressling	Pressed article; molding
Pr	Press-stahl	Pressed steel
Pr; PrS	Press-stoff	Thermosetting plastic; (lit Pressed material)
Pr	Protze	Limber (Arty), caisson
(Pr f 12 cm GrW 42)	(Protze für 12 cm Granatwerfer 42)	(Limber for 120 mm mortar pattern 42)
Prf; Prüf	Prüfung	Test examination; check
PrGesch	Phosphorgeschoss	Phosphorus projectile
PrGr; PrG	See PropGr	

prM	preussische Meile	Prussian mile (7.532 km)
Prhm	Phosphormunition	Phosphorus ammunition
Proj	Projektil	Projectile
PropGr; Propgr; PrGr	Propagandagranate	Propaganda shell; leaflet rocket
Proz	Prozent	Per cent (%)
PrU	Pressstoffumhüllung	Casing or jacket made of pressed material
PrW	See Prf; Prüf	
PrW	Propagandawerfer	Launcher for propaganda projectile
PS	Pferdestärke	Horsepower
PSGr; PzGr	See PzSGr	
PStz (such as in 21 cm PStz DO)	Pulverstütze (21 cm Pulverstütze DO)	Propellent support (Propellent support DO in 210 mm ammunition)
PSW	See PzSpW	
PT	Pulvertemperatur	Ammunition temperature
Pulv	See P; Pulv	
PulvFabr	Pulverfabrik	Powder factory
Pv	Pulver	Designation of slow-burning powder used in time-delay Fz
PvSt (such as in KZ ZerlPvSt)	Pulver, Stahl (Kopfzünder,Zerleger-Pulver, Stahl)	Powder (black), steel (Nose fuse self-destroying black powder unit, steel body)
Pwg	See Pzwg	
PWM	See PzWuMi	
Pz-32	———	Designation of a pressure type igniter used in some improvised mines (TM 9-1985-2, p 298)
Pyr	Pyrotechniker	Artificer (Military) See Feuerwerker
Pz	Panzer	Tank; armor; armored vehicle
PzAbt(F)	Panzerabteilung (Flammenwerfer)	Armored flame-thrower detachment
PzAbwAbt	Panzerabwehrabteilung	Antitank battalion
PzB	Panzerbüchse; Panzerabwehrbüchse	Antitank rifle
PzBefWg; gpBefWg	Panzerbefehlswagen; gepanzerter Befehlswagen	Commander's armored vehicle
PzBeoWg	Panzerbeobachtungswagen	Armored vehicle used for artillery spotting
PzF	Panzerfaust	A/T shaped charge missile
PzF 60	Panzerfaust 60	Hand operated grenade launcher A/T, 60 (weight 93 lb)
PzF (kl)	Panzerfaust (klein)	Small hand operated grenade launcher, A/T (weight 51 lb)
PzFuWg	Panzerfunkwagen	Armored radio car
Pzgr; PzGr	Panzergranate	Solid AP projectile
Pzgr 39	Panzergranate 39	APC BC HE (armor-piercing capped, ballistic cap, high explosive) shell, type 39
Pzgr 40	Panzergranate 40	AP shell with a tungsten carbide core, type 40
Pzgr 41	Panzergranate 41	AP shell with a tungsten carbide core for tapered bore gun, type 41
Pzgr Patr (2.8 cm Pzgr Patr 41)	Panzergranate Patrone (2.8 cm Panzergranate Patrone 41)	Antitank projectile in fixed ammunition (28 mm AP shell for 28/20 mm Tapered-Bore Gun called SPBu 41)
Pzgr Patr L'spur (Rz)	Panzergranate Patrone Leuchtspur (Reizstoff)	AP-T fixed round containing a charge of irritant
PzGr(W)	Panzergranate (Weicheisen)	Antitank shell, soft iron
PzJäg; PzJg; PJ; PJäg	Panzerjäger	Tank destroyer (lit Tank hunter) (See also JgdPz)
PzJagK; PJK; PzJK	Panzerjägerkanone	A/T gun (lit Tank hunter's gun)
PzK (such as in KGr 15 PzK)	Panzerkopf (Kanone-Granate 15 mit Panzerkopf)	Armor-piercing cap (Cannon shell 15 with AP cap)
PzKpfw; Pz; PzKpfWg (See also Panzer in the descriptive part)	Panzerkampfwagen	See Vocabulary
PzKw; Pkw	Panzerkraftwagen	Armored motor car
PzMi 43	Panzermine 43	Magnetic A/T mine 43
PzSf; PzSfl	Panzer-Selbstfahrlafette	Armored self-propelled gun mount
PzSGr; PSGr; PzGr	Panzerstahlgranate	Steel armor-piercing shell (with small HE content)
PzSprGr; Pzsprgr	Panzersprenggranate	Antitank-high explosive shell
PzSpWg; PSW; PSpW; PSPW	Panzerspähwagen	Armored reconnaissance car; armored scout vehicle
PzT	Panzerturm	Turret of a tank
Pzwg; Pwg	Panzerwagen	Armored combat vehicle
Pzwff	Panzerwaffe	Armored troops; tank troops
PzWK; PzWkpr	Panzerwurfkorper	Hollow charge A/T projectile fired from signal pistol
PzWK 42 LP	Panzerwurfkorper 42 für Leuchtpistole	Hollow charge A/T projectile pattern 42 fired from 23 mm signal pistol
PzWuMi; PWM; PzWM	Panzerwurfmine	Hollow charge A/T grenade or mine

Q

Q; QuBel	Querschnittsbelastung	Cross-sectional load
qcm	Quadratzentimeter	Square centimeter
Qmstr; QuM	Quartiermeister	Quartermaster
Qu	Querschnitt	Profile; cross-section

R

R; Rak	Rakete	Rocket
R	Rauchentwickler	Smoke generator
R; Ro	Rohr	Barrel (G); pipe; tube
R; Ro	Röhre	Radio tube; nozzle
R; RP	Röhrenpulver	Tubular propellant
R	Rückstosslader	Recoil-operated gun
r; rd	rund	round
R	Rundkopfgeschoss	Round-headed projectile
(r); russ	russisch	Russian (marking on equipment)
R8; R11, etc (black stencilling)	Rauchentwickler Nr 8, Nr 11, etc	Shell containing smoke generator No 8, No 11, etc
R-3	Rheintochter 3	Daughter of the Rhein 3 (radio-controlled AA rocket)
Rad	Radio	Radio (See also RF)
RadfAbt; RdfAbt	Radfahrabteilung	Bicycle detachment
RAg (in rocket launcher designation 21 cm RAg M42)	Raketen Ag (21 cm Raketen Ag M42)	Designation of a single-barreled launcher for 21 cm RLg Rocket (TM 9-1985-2, p 259)
Raup; Rp	Raupe	Caterpillar track
RaupFzg; RpFzg	Raupenfahrzeug	Full-track vehicle
RaupSchl; RpSchl	Raupenschlepper	Caterpillar tractor
RAZ 51	Raketenaufschlagzünder 51	Rocket percussion fuze, screwed directly into the nose of the warhead (TM 9-1985-2, p 235)
rBattr	reitende Batterie	Mounted battery
RblF	Rundblickfernrohr	Panoramic telescope
R-Boot	Räumboot; Minenräumer	Mine sweeper
R BS (such as R 100 BS)	——— (Rakete 100 BS)	Marking on an air-to-air incendiary rocket equipped with "Oberon Gerät" (TM 9-1985-2, p 255)
RhZdh	See RZdh	
Rcklf	Rücklauf	Recoil (of weapons)
Rd	See Radf	
Rd	Reinsdorf	Reinsdorf Plant (See under Warplants in descriptive section)
Rdf	See Radf	
RDg; RDG (such as 8.6 cm RDg 1000)	Raketendrahtgerat (8.6 cm Raketendrahtgerät 1000)	Rocket wire barrage (86 mm rocket contg a parachute suspended spool of wire with no explosive attached (TM 9-1985-2, p 240)
Rdr	Rechtsdrall	Clockwise rifling (Weapons)
Rdr	Reichsdruckerei	Government Printing Office
RDZ	Randdüsenzünder	Rimvent fuze (Ammo) (See elRDZ)
Rev	Revolver	Revolver
RevK	Revolverkanone	Revolver gun
REw	Rauchentwickler	Smoke generator
Rf; R-frei	Rohrfrei	Empty gun barrel
RF	Rundfunk	Radio; broadcasting
Rf (such as 7.5 cm RfK 43)	Rückstossfrei; Rücklauflos (7.5 cm Rückstossfrei Kanone 43)	Recoilless (75 mm Recoilless cannon, pattern 43)
RFK; RfK	Rückstossfreiekanone	Recoilless gun (See also DüW)
RFR	See under Warplants (descriptive section)	
RfW	Rückstossfreier Werfer	Recoilless launcher
Rg	Ring	Ring
RgK	See RK	
RgP	Ringpulver	Flat ring (washer) type propellant (used in some howitzers and mortars)
RGr	Raketengranate	Rocket-assisted projectile
RGr	Rauchgranate	Smoke shell
Rgfkn (such as DOV Rgfkn 15)	Ringstütze	Ring on tripod support
Rh	Rhein	Rhein (river)

Rh; Rhm	See under Werfplatte in descriptive part	
RhS (in fuze designation such as AZ 150 RhS)	Rheinmetall S (Aufschlagzünder 150 Rheinmetall S)	Marking on the PD fuze 150 manufd by the Rheinmetall Co (TM 9-1985-3, p 564)
RIM	Reichs Innen Ministerium	Department of the Interior
Rittm; Rtm	Rittmeister	Captain (cavalry)
RK	Rauchkörper	Smoke filler (Ammo); smoke-puff charge (simulated fire)
RK; RgK	Ringkanone	Built-up gun barrel; jacketed gun
RK	Rohrkarre	Tubular gun carriage
RKfB	Rauchkörper für Beobachtungszwecke	Smoke puff charge for observation purposes (such as in maneuvers)
RKfS	Rauchkörper für Schiedsrichter	See in Vocabulary
RL	Radlafette	Wheeled gun carriage
RL; RLaf	Röhrenlaffette	Tubular gun carriage
RLG; RLg	Raketen Leuchtgerät	Rocket flare device
(21 cm RLg)	(21 cm Raketen Leuchtgerät)	[210 mm Rocket containing a parachute suspended flare (TM 9-1985-2, pp 258-9)]
RLGS	Raketen Leuchtgerät Scheingeschoss	Rocket illuminant simulating device
RLM	Reichsluftfahrtministerium	Air Force Ministry
RM	Reichsmark	See in Vocabulary
(rm)	rumänisch	Rumanian (marking on equipment)
RMi	Riegelmine	Cross bar mine
(RMi 43)	(Riegelmine 43)	A/T mine 43 described in TM 9-1985-2, p 272)
R-Mun	Rillenmunition	Rimless cartridge case of SA ball ammo
Rö (such as in 21 cm RöGrBe)	Röchling (21 cm Röchlinggranate, Beton)	Name of metallurgical plant in Saar (210 mm Röchling Anticoncrete Projectile)
Rohrbr	Rohrbremse	Recoil brake (Arty)
Rot (black stencilling)	Rot	HE shell giving red smoke burst
Rp	See Raup	
RP	Röhrenpulver	Propellant in the form of long tubes (Usual form of German cannon propellant)
RP 12	Röhrenpulver 12	Tubular NG propellant of calorific value 950 kcal/kg used in Naval guns since about 1912
RP 32	Röhrenpulver 32	Tubular NG propellant of cal value 820 kcal/kg which replaced RP 12 in Naval guns
RP 38	Röhrenpulver 38	Tubular DEGDN propellant of calorific value 820 kcal/kg which replaced RP 32
RP 38N	Röhrenpulver 38, Nitronaphthalin	Same as above but it contained α-nitronaphthalene
RP 40	Röhrenpulver 40	Tubular DEGDN-NC propellant which superseded RP 38 in Naval guns. Its calorific value varied between 690 and 730 kcal/kg
RP 40 N	Röhrenpulver 40, Nitronaphthalin	Same as above but containing α-nitronaphthalene
Note: None of the RP 40 propellants contained potassium salts		
R-Patr	Rauchpatrone	Smoke signal cartridge
RPC/12	Röhrenpulver Construktion 12	Tubular propellant used in Naval guns type 1912
RPC/32	See Röhrenpulver C/32 (descriptive section)	
RPE (P)	Röhrenpulver (Einheitspulver)	Standard tubular propellant (See also EP)
RPzB	Raketenpanzerbüchse	A/T rocket launcher
(8.8 cm PzB54)	(8.8 cm Panzerbüchse 54)	88 mm A/T rocket launcher type 54, called Panzerschreck)
RPzBGr	Raketen Panzerbüchse Granate	Hollow charge rocket fired from A/T rifle
(8.8 cm RPzBGr 4322)	(8.8 cm Raketen Panzerbüchse Granate 4322)	[88 mm HE HoC rocket, fin stabilized (TM 9-1985-2, pp 243-5)]
RS	Raketenstart	Rocket-assisted takeoff
RS; Rs (black stencilling)	Reizstoff	Shell containing irritant filling, such as tear gas or lacrimator
RSB	Raketenstartbombe	Rocket-assisted bomb
RSflB-Schule	Reichs-Segelflugbauschule	Reich Glider Construction School
RSpgr	Raketensprenggranate	HE rocket shell
(8.6 cm RSpgr L/4.5 und L/5.5)	(8.6 cm Raketensprenggranate, Lange 4.5 und 5.5)	[86 mm solid propellant rockets 4.5 and 5.5 calibers long (TM 9-1985-2, pp 256-7)]
(8.6 cm RSpgr 400 Wsm)	(8.6 cm Raketensprenggranate 400, Weismann)	(86 mm Naval HE rocket spin-stabilized, Weismann) (TM 9-1985-2, p 240)
RSSG	Raketen Scheinschuss Gerät	Rocket signal simulating device
rtBattr	reitende Batterie	Mounted battery
Rtm	See Rittm	

Rü; Rüst	Rüstung	Armament; Equipment
Rückl	Rücklauf	Recoil (of a gun)
(rum)	rumänisch	Rumanian (marking on equipment)
(russ); (r)	russisch	Russian (marking on equipment)
RVfW	Raketen Vielfachwerfer	Multiple rocket launcher
RW	Raketenwerfer	Rocket launcher
(8.8 cm RW 43)	(8.8 cm Raketenwerfer 43)	(88 mm wheeled rocket launcher, called Püppchen)
R-Wagen	Rungenwagen	Heavy freight car (15 tons)
RWg	Rohrwagen	Barrel carriage
RZ	Raketenzünder	Rocket igniter (See also ERZ)
Rz	Rohrzerspringer	Barrel burster (Arty)
RZdh	Reibenzündhütchen	Friction type cap
RZP	Roheisenzündpulver	Raw iron igniter powder (used in prepn of sintered iron items)

S

S	Säure	Acid
S; s	scharf	Live (Ammo)
S	Schrapnell	Shrapnel
s	schwehr	heavy
s (marked on a fuze)	schwer	Heavy fuze (for use in guns with high shell acceleration)
S; SL	Seelenlänge	Gun barrel length; tube length
S	Sekunde	Second (sec)
..S/30 (in fuze designation)	Sekunden 30	Time fuze with maximum running time of 30 sec
..S/90/45	Sekunden 90/45	Time fuze with maximum running time of 45 sec modified to 90 sec
..S/45-125	Sekunden 45-125	Time fuze with no setting possible below 45 sec, and with max running time of 125 sec.
S*	See Patr S*	
s; S	sicher	safe
(s)	spanisch	Spanish (marking on equipment)
S; S-Gesch	Spitzgeschoss	Pointed bullet with a flat base
S; SG; SGew	Seitengewehr	Bayonet (lit Side arm)
S-42	Seitengewehr 42	Bayonet pattern 42
S; St (such as Patrh S)	Stahl (Patronenhülse Stahl)	Steel (such as steel cartridge)
S	Süd	South
SA; sA	schwere Artillerie	Heavy artillery, called in the U S A "medium artillery"
SA	schwere Abwurfbombe	High capacity bomb (Grossladungsbombe) (Loading factor up to 80%)
(SA 4000)	schwere Abwurfbombe 4000	Designation of a 4000 kg high capacity bomb (TM 9-1985-2, pp 43-4)
Säb	Säbel	Saber; sword
SB	Splitterbombe	Fragmentation (A/P) bomb
SB	Sprengbombe	Thinwalled high explosive bomb; demolition bomb (Loading factor up to 75%)
SB 400 (Kugel K)	Sprengbombe (Kugel B)	Spherical, hydrostatically operated, aircraft-laid, skip bomb, known in the U S A as Kurt Apparatus (TM 9-1985-2, p 14)
S Be (B)	Splitter Beton (Bombe)	Concrete fragmentation bomb
SBC (B); SBrC (B)	Sprengbrandcylindrische (Bombe)	HE-incendiary cylindrical bomb, contg either phosphorus or thermit (TM 9-1985-2, p 51)
SBe (B); SplBe (B)	Splitterbeton (Bombe)	Concrete fragmentation bomb (Loading factor about 30% HE)
Note: This bomb is one of the versions of SD		
SC (B)	Sprengcylindrische (Bombe)	Thin walled HE-GP bomb; loading factor about 50%)
(SC 1800 B)	(Sprengcylindrische 1800 kg Bombe)	[HE cylindrical bomb, known as "Satan" (TM 9-1985-2, p 12]
Note: This type of bomb was also called "Minenbombe"		
(SC 2500 B)	(Sprengcylindrische 2500 kg Bombe)	[HE cylindrical bomb, known as "Max" (TM 9-1985-2, p 13)]
SCD (B)	Sprengcylindrisch-dickwandige Bombe	HE cylindrical, thick-walled bomb (Semi-armor-piercing bomb)
(SCD 1700 B)	(Sprengcylindrisch-dickwandige 1700 kg Bombe)	(1700 kg SAP bomb)
Sch	Schanze	Fieldwork; entrenchment
Sch	Scheinwerfer	Searchlight; highlight
Schalld	Schalldämpfer	Silencer; muffler
Schb	Scheibe	Target
Schbw	Schiessbaumwolle	Guncotton

SchGrabK	Schützengrabenkanone	Trench gun
Schiessb	Schiessbecher	Rifle grenade discharger (launcher)
Schiessb HlGr, 6.6 cm	6.6 cm Schiessbecher Hohlladung Granate	66 mm Hollow charge grenade launched from Schiessbecher
Schiessw	Schiesswesen	Ballistics; gunnery
Schles	Schlesien	Silesia
Schlgzdschr; schlZSchr	Schlagzündschraube	Threaded percussion primer
SchlW	Schleppwagen	Tow car (motor vehicle)
SchMi	See SchüM	
SchPlJ	Schiessplatz Jüterbog	Jüterbog Firing Range
SchPlK	Schiessplatz Kummersdorf	Kummersdorf Firing Range
Schr	Schrapnell	Shrapnel
Schr Mi	See S-Mi	
SchrPatr [such as 6.5 cm SchrPatr 223 (j)]	Schrapnellpatrone [6.5 cm Schrapnell Patrone 223 (jugoslawisch)]	Shrapnel, fixed round (65 mm Yugoslav Shrapnel Fixed Round 223)
SchüMi; SchMi; Schümine; S-Mi	Schützenmine	A/P land mine (See also SchMi)
Schwpv	Schwarzpulver	Black powder
SD (B)	Spreng, dickwandige Bombe	HE thick-walled bomb (Loading factor 20-30%)

Note: This bomb was also called "Splitterbombe" (fragmentation bomb). It was SAR (semi-armor-piercing)

SDHL-B	Spreng, dickwandige (Hohlladung) Bombe	HE-HoC thick-walled bomb; SAP-HoC-A/T bomb
SD (k)-B	Spreng, dickwandige (klein) Bombe	Small HE thick-walled fragmentation bomb
SdKart	Sonderkartusche	Special propellent charge
SdKfz	Sonderkraftfahrzeug	See in Vocabulary and under Panzer
SdKfz	Sprengdienst Kraftfahrzeug	Demolition service motor vehicle
(Goliath Sdkfz 302)	(Goliath Sprengdienst Kraftfahrzeug 302)	(Demolition service vehicle, carrying prepared charges of 50/50-RDX/TNT) (remote controlled)
SdrGesch	Sondergeschoss	Special projectile
Seeflgz	Seeflugzeug	Seaplane; hydroplane
Sehr	Sehrohr	Periscope (submarine, tank); telescope
Sek; S	Sekunde	Second
SEL	See SELf	
SelbstflLaf	See Sf; Sfl	
SELf; SEL	Selbstlade-Einstecklauf	Subcaliber barrel for automatic weapon
Sf; Sfl; SelbstflLaf	Selbstfahrlafette	Self-propelled (SP) gun (lit Self propelled gun mount)
SF	Schutzfeder	See in vocabulary
sFH	schwere Feldhaubitze	Medium field howitzer
SFK	Schnellfeuerkanone	Rapid-fire cannon
SG	See S; SG; S-Gew	
SG 39	Schmidding Gerät 39	Schmidding device 39 (see descriptive part)
S-Ger	Sondergerät	Special purpose device
S-Gesch	See S; S-Gesch	
S-Gew	See S; Sg; S-Gew	
SgFl	Segelflieger	Glider
sGrW	schwerer Granatwerfer	Heavy mortar
sHT	schwere Haubitze-in-Turm	Heavy howitzer for fortifications (lit Heavy howitzer in tower)
Si	Siebel	Designation of airplanes built by Siebel Co
sIG; SIG; sJG	schweres Infanteriegeschütz	Heavy infantry gun
SigP	Signalpistole	Signal pistol
SigR	Signalrakete	Signal rocket; flare
SigW	Signalwerfer	Signal flare projector
SiK (E)	Siefried Kanone (Eisenbahn)	Siegfried railroad cannon
sJG	See sIG	
sJgrZ	schwerer Jägergranatzünder	Heavy fuze for light infantry shell
SK	Schiffskanone	Ship cannon
SK C/12	Schiffskanone, Construktion 12	Ship cannon type 1912
SK L/45	Schiffskanone Lauflänge 45	Ship cannon with barrel (tube) 45 calibers long
SK; SLK	Schnellfeuerkanone; Schnelladekanone	Rapid-fire gun; rapid-loading gun
Sk	Sockel	Pedestal; swivel
S-Kar	Sonderkartusche	Special propelling charge (S-L Ammo)
SkL; SockLaf	Sockellafette	Pedestal mount
SL	See- und Landflugzeug	Amphibious plane
sLdgW	schwerer Ladungswerfer	Heavy spigot mortar
SLK	See SK; SLK	

S-M	Seemile	Nautical mile; knot (1855 meters; 6080 feet)
sMG	schweres Maschinengewehr	Heavy machine gun
S-Mi; S-Mine	Schrapnellmine; Spreng- und Schrapnell Mine	Shrapnel mine; A/P mine filled with shrapnel balls; (nicknamed "silent soldier")

Note: Abbreviation S-Mi, was also used to designate a Schützenmine, usually abbreviated as SchüMi (q v)

SmE	Spitzgeschoss mit Eisenkern	Pointed bullet with iron core
S-MiZ-35	Schützenminen Zünder 35	Pressure type igniter used in A/P land mine 35 or in bounding mine (TM 9-1985-2, p 299)
S-MiZ-44	Schützenminen Zünder 44	Push-pull type igniter used in A/P land mine 44 or in some improvised mines (TM 9-1985-2, p 294)
SmK	Spitzgeschoss mit Stahlkern	Pointed bullet with steel core (AP bullet)
SmKGl'spur	Spitzgeschoss mit Stahlkern und Glimmspur	Pointed bullet with steel core and dim tracer (AP-T bullet)
SmK(H)	Spitzgeschoss mit Stahlkern (gehartet)	Pointed bullet with hardened steel core (super AP bullet)
SmKL'spur	Spitzgeschoss mit Stahlkern und Leuchtspur	Pointed bullet with steel core and tracer (super AP-T bullet)
S-Mun	scharfe Munition	Live ammunition
S-Mun	Spitzmunition	Pointed ball ammunition
sMW	schwerer Minenwerfer	Heavy mortar
SO	Südosten	Southeast
SockLaf	See SkL	
sond; S	sonder	Special; separate
SondKart	Sonderkartusche	Special propellent charge
Sp; Spr	Spreng	Explosive
sPak	~~schwere Panzerabwehrkanone~~	Heavy A/T gun
SP (B); Spl (B)	Splitter (bombe)	Fragmentation bomb; antipersonnel (A/P) bomb
SPBe (B); SplBe (B)	Splitterbeton (bombe)	Concrete fragmentation bomb
sPBü-41	schwere Panzerbüchse 41	Heavy tapered-bore gun
SpBr	See SprBr	
SpBü	See SprBü	
SP-Gesch	Spitzgeschoss	Pointed bullet
Spgr; SpGr; SpGr	Spurgranate	A shell with tracer
SpgrZmK	Sprenggranatenzünder mit Klappensicherung	HE shell fuze with folding safety device
SPh	Spitzgeschoss, Phosphor	Pointed bullet with phosphorus
SpKps; SprK; SprKps	Sprengkapsel	Detonating cap
SplBo	Splitterbombe	Fragmentation bomb; splinter bomb
SplGr	Splittergranate	Fragmentation shell
SPr	See SP-Gesch	
Spr; Sp (such as in 28 cm Wfk Spr)	Spreng (28 cm Wurfkörper Spreng)	High explosive (280 mm HE Rocket)
SprB; SprBo	Sprengbombe	(High explosive bomb)
SprBr; SprBd	Sprengbrand	HE-Inc filling
SprBü; SprB (SprBü 02/24)	Sprengbüchse (Sprengbüchse 02/24)	Demolition slab (Demolition slab, 1 kg TNT)
Sprgldg; SprLdg	Sprengladung	HE charge; demolition charge
Sprgr; Spgr Gr	Sprenggranate; Granate	High explosive shell
Sprgr-41	Sprenggranate 41	HE shell for tapered bore gun
Spgr L (such as in 15 cm Sprgrl)	Sprenggranateladung (15 cm Sprenggranateladung)	HE filling for shell (150 mm HE shell)
Sprgr mK	Sprenggranate mit Klappensicherung	HE shell with folding safety device
Sprgr Patr	Sprenggranate Patrone	HE round of fixed ammunition
SprgrPatr KP	Sprenggranate Patrone für Kampfpistole	HE grenade for rifled bore signal pistol, caliber 27 mm
SprK	See SpKps and SprKpr	
SprKab	Sprengkabel	Blasting ignition cable
SprKpr; SprK	Sprengkörper	Blasting charge; demolition charge
(SprK 88)	(Sprengkörper 88)	Prepared demolition charge, 200 g picric acid
SprKps	See SpKps	
SprLdg	See Sprgldg	
SprPatr 28	Sprengpatrone 28	Demolition cartridge, 100 g TNT
SprSchwP	Sprengschwarzpulver	Blasting black powder
SprSt	Sprengstoff	Explosive
Sprzlaf	Spreizlafette	Split-trail carriage
S-Pulver	Pulver für scharfe Munition	Powder for live ammunition
SPW; SPzWg	Schützenpanzerwagen	See in Vocabulary
sPzB; SPBü	schwere Panzerbüchse	Heavy A/T rifle

(2.8/2.0 cm SPzBü 41)	(2.8/2.0 cm schwere Panzerbüchse 41)	(28/20 mm Tapered bore A/T rifle 41)
sPzKpfWg	schwerer Panzerkampfwagen	Heavy tank
sPzSpWg	schwerer Panzerspähwagen	Heavy armored scouting (reconnaissance) car
SR	Sehrohr	Periscope; telescope
Sk	Schraubkappe	Screw cap
sS	schweres Spitzgeschoss	Heavy pointed bullet with metal jacket; streamlined (boat tail) bullet
S S	Zeitschrift für das gesamte Schiess- und Sprengstoffwesen	Journal of Propellants and Explosives, now called Explosivstoffe
ss	schwerste; überschwere	heaviest; superheavy
ssA	schwerste Artillerie	Heaviest Artillery (corresponds to American Heavy Artillery)
sSmK	schweres Spitzgeschoss mit Kern	Heavy pointed bullet with core
St	Stahl	Steel
St	Stellstift; Stellschlüssel	Fuse setter; Fuse adjuster wrench
Stabo-B (such as in Sc 50 Stabo)	Stachelbombe (Sprengcylindrische Bombe 50 Stabo)	Nose spike (fuze extension rod) [HE cylindrical bomb having a one piece body with a threaded lug forged to the nose of the bomb and a spike (TM 9-1985-2, p 6)]
Stahlw	Stahlwerke	Steel works
Stb	Stab	Staff
StbP	Stäbchenpulver	Chopped tube propellant
StbP	Staubpulver	Finely granulated black powder
StB (B)	Stabbrandbombe	Stick type incendiary bomb
StdMi	Strandmine	Beach mine; shore mine
Stg (black stencilling)	Stahlguss (granate)	Cast steel shell
Stg; Stggr	Stahlgeschoss; Stahlgussgranate	Light case shell of cast steel (TM 9-1985-3, p 349)
Sthg; StHg; StiGr	Stielhandgranate; Stielgranate	Stick hand grenade; rodded or potato masher hand grenade
StiGr	See Sthg	
StK	Stahlkern	Steel core
Stö	Stössel	Tappet; hammer (Fz)
Sto-Mi	Stockmine	A/P concrete picket type mine
Sto-Mi	Stolperdrahtmine	Trip-wire mine
StP	Sternenpulver	Star propellant (flat 6 pointed stars)
StrP	Streifenpulver	Strip propellant
StuA	Sturmartillerie	Assault artillery
StuG; StuGesch	Sturmgeschütz	Assault gun (self-propelled)
StuG -44	Sturmgewehr -44	Stormtrooper's rifle (previously called MP-44)
StuH	Sturmhaubitze	Assault howitzer (self-propelled)
StuK	Sturmkanone	Assault cannon (self-propelled)
Stuka	Sturzkampfflugzeug	Dive fighter-bomber
St u StSr	Stössel und Stösselschraube	Tappet and tappet screw (Fz)
StZ	Stechzünder	Inserted igniter
Stzb	Sturzbomber	Dive bomber
StzSr	Stützschraube	Support screw
Sulfitri	Sulfittrinitrotoluol	TNT purified by Na sulfite
SVA	See under Warplants, etc in descriptive part	
SW	Scheinwerfer	Searchlight
SW	Südwest	Southwest
sW	schwerer Werfer	Heavy smoke shell mortar
SwB [such as in SwB K5(E)]	Schwenkbahnbettung [Schwenkbahnbettung für Kanone 5 (Eisenbahn)]	Turntable platform [Turntable platform for railroad-cannon 5]
sWG	schweres Wurfgerät (Werfergerät)	Heavy smoke mortar equipment
sWuR	schwere Wurfrahmen	Heavy framework-type rocket launcher
SZ; SZerl	Selbstzerleger	Self destruction charge (Proj)

T

T; Tk	Tank	Tank
T	Temperatur	Temperature
t; To	Tonne	Metric ton (1000 kg = 2205 lb)
T; Torp; Tp	Torpedo	Torpedo
T (marked on a fuse)	Trolitul	Fuze body, such as "VgrZ T" made of plastic material "Trolitul"
(t)	tschecho-slowakisch	Czechoslovakian (marking on equipment)
T; Tu	Turm	Turret; tower
TAL	See under Warplants, etc in descriptive part	

TaschMun	Taschenmunition	Small arms ammunition in pouches
TATO	Tag-Tonne	Metric Tons per day
TbtsK	Torpedoboots' Kanone	Torpedo boat's heavy gun
Teilkart	Teilkartusche	Partial propellent charge; increment charge
T-Falle	Tankfalle	Tank trap
TG	Turmgeschütz	Turret piece (gun)
TH	Turmhaubitze	Turret howitzer
ThBrK (E)	Theodor Bruno Kanone (Eisenbahn)	Theodor Bruno railroad cannon
ThK	Theodorkanone	Theodor cannon
Thür	Thüringen	Thuringia
Tk	See T; Tk	
TK	Turmkanone	Turret cannon
Tkst	Tankstelle	Filling station; gas station
T-Mi; TMi	Tellermine	Disk-type A/T mine (TM 9-1985-2, p 270)
TMiZ	Tellerminenzünder	Igniter for disc-type A/T mine
T Mun	T-Mun	Tank ammunition
TMZ-35, 42 and 43	Tellerminenzünder, 35, 42 und 43	Types of pressure igniters for use in various T-Minen and Pilz-Minen (TM 9-1985-2, pp 301-5)
To	See T; To	
ToMi	Topfmine	Pot-shaped land mine
Torp	See T; Torp	
TorpMotB	Torpedomotorboot	Torpedo motor boat
Tp	Transport	Transport
Tp (red or black stencilling)	Tropenmunition	Ammunition suitable for use in tropical climate
Tr; Trbldg	Treibladung	Propellent charge
TrMi (such as: KgTrMi 42)	Treibmine (Kugeltreibmine 42)	Floating (unanchored) automatic contact mine (spherical floating mine 42)
TS	Treibspiegel	See in Vocabulary
TS	Treibspiegelgeschoss	See in Vocabulary
TStz (such as 21 cm TStz DO-Wu)	———————	Meaning unknown to us
Tu; T	Turm	Turret; tower
TuMg; TMG	Turmmaschinengewehr	Turret or tower machine gun
TVA	See under Warplants (Descriptive section)	

U

u	und	and
(u)	ungarisch	Hungarian (marking on equipment)
U	Unterlafette	Bottom gun carriage
U (black stencilling)	Unterrichtsgeschoss	Instruction (practice or drill) projectile
U; U-Boot	Unterseeboot	U-boat; submarine
UA	Unterseebootsabwehr	Defense against submarines
Üb	Übung	Practice
Üb (white stencilling)	Übungsgeschoss	Practice projectile; shell containing black powder
ÜbAl	Übungsgeschoss mit Aluminium	Practice shell giving on burst a bright flash (due to the presence of Al)
ÜbB (white stencilling)	Übungsgeschoss B	Practice shell giving on burst a cloud of smoke (due to the presence of sulfur trioxide)
Übg; ÜbGr	Übungsgranate	Practice shell; drill shell
ÜbMi	Übungsmine	Practice mine
ÜbR (white stencilling)	Übungsgeschoss, Rot	Practice shell giving red smoke burst
ÜbS	Übungsgeschoss, Schwarz	Practice shell giving black smoke on burst
ÜbSpK	Übungssprengkörper	Dummy blasting charge
ÜbW	Übungsgeschoss, Weiss	Practice shell giving white smoke on burst
Uffz	Unteroffizier	Noncommissioned officer, corporal
Ug/M; Umdr/M	Umdrehungen pro Minute	Revolutions per minute (rpm)
ÜKr	Übertragungs Körper	Induced detonation charge
UKW	Ultrakurzwelle	Ultrashort wave (Rad)
ÜLdg	Übertragungsladung	Propagation charge; primer charge
umg	umgearbeitet; umgeändert	reworked; converted; modified
(92 umg)	(92 umgeändert)	(1892 pattern converted)
uml	umlaboriert	equipped; outfitted
UtvK	———————	U-boat cannon (such as 149 mm)
UW	Uhrwerk	Clockwork mechanism (Fz)

UZ; UWZ	Uhrwerkzünder; Uhrzünder	Clockwork fuze

V

V	Veränderung	Change; alteration; modification
v	verbessert	improved
v; verb	verboten	forbidden; prohibited
V (such as 5 cm PzgrPatr 42 V)	Verbundgeschoss (5 cm Panzergranate Patrone Verbundgeschoss)	Compound (jacketed) projectile (50 mm AP-T fixed round ammo, pattern 42 with jacketed projectile)
v	vereinfacht	simplified
V; Verg	Vergeltung	Retaliation; reprisal; revenge
V-1	Vergeltungswaffe Eins	Retaliation weapon 1 (V-1) (See Descriptive part)
V-2	Vergeltungswaffe Zwei	Retaliation weapon 2 (V-2) (See descriptive part)
V-3 or HDP	Vergeltungswaffe Drei	Retaliation weapon 3 (V-3)
V (in fuze designation)	Verzögerung	Delay
(1/V)	(Erste Verzögerung)	[First delay (short delay)]
(2/V)	(Zweite Verzögerung)	[Second delay (long delay)]
(0.05 Sek V)	(0.05 Sekunden Verzögerung)	(1/20th second delay)
VA, V_2A, etc	————————	Types of stainless steel, generally contg Ni, Cr, Mo and used in German acid and explosives plants
VDM	See under Warplants (descriptive section)	
Verf OKH	Verfügung des Oberkommandos des Heeres	Army Regulations
Verg	See V; Verg	
Verh	Verhältnis	Relation
verl A	verlastete Artillerie	Pack artillery
Verrgl	Verriegelung	Locking mechanism (weapons); barricade
Vers	Versager	Misfire; dud
Vers Anst	Versuchsanstalt	Experimental station; research laboratory
VersAnst Hdfw	Versuchsanstalt für Handfeuerwaffen	Experimental station for small arms
VersBt	Versuchsboot	Experimental boat
VerschwLaf	Verschwindlafette	Retractable gun mount
verst; Verst	verstärkt	reinforced
VerzZ	Verzögerungszünder	Delay-action fuze
vf	vereinfacht	simplified
VG 1	Volkssturmgewehr Eins	See in Vocabulary and under Weapons
Vierlg	Vierling	See in Vocabulary
vk; Vk (black stencilling)	verkürzt	shortened
Vkkh	Verkürztekammerhülse	Shortened central tube (shrapnel)
vkL'spur	verkürzte Leuchtspur	Shortened tracer trail
VLdg	Verbesserteladung	Adjusted charge (lit improved charge)
VM-stoff	Victor Meyer Stoff	A camouflaged name for Mustard gas
vnull; Vo; V-Null	Velocitas-Null	Initial velocity; muzzle velocity (Proj)
Vorh	Vorholer	Counterrecoil mechanism
Vorkart	Vorkartusche	Front increment charge in separate-loaded ammunition (See also Teilkart)
Vorl	Vorlauf	Counterrecoil
Vorl	Vorlage	Flash-reducing wad
vorm	vormals	formerly
Vorr-; vorne	————————	Front; anterior (charge, etc)
Vp; VpGesch	Verpackungsgeschoss	Dummy round for vehicle loading practice
VRP	verkurzten Röhrenpulver	Tubular propellant cut into short lengths
Vrst	Vorstecker	Safety pin (bomb, mine, grenade); lug (fuze)
VStA	Vereinigte Staaten von Amerika	United States of America
VrzZ; VZ	Verzugszündung	Safety fuzing
VrzZt; VZt	Verzugszeit	Safety time (in fuzing)
Vz	————————	Model designation (Czech fuzes)
VZ	Verzögerungszünder	Delay-action fuze
VZ	Vorzugszünder	Safety fuze
VZ 80	Verzögerungszünder 80	"All-ways action" fuze described in TM 9-1985-2, p 189; used in V-1 bomb)

W

W	Wache	Guard; watch; sentinel
W; Wa	Waffen	Arms; weapons; ordnance
W	Offizier des Waffenwesens	Ordnance officer
W	Wagen	Wagon; vehicle
W (such as 2 cm SprgrPatr L'spur W)	Wärmeübertragung (2 cm Sprenggranate Patrone Leuchtspur Wärmeübertragung)	Heat transfer (20 mm HE-T fixed round self-destroying by heat generated by tracer)
W; Wehrm; Wm	Wehrmacht	Armed Forces
W (white stencilling)	Weicheisenkern	Soft iron core projectile
w	weiss	white
W; Werf; Wrf	Werfer	Shell mortar; launcher (rocket, signal)
W	West	West
W (in shell designation)	Wolfram	AP subcaliber shell with tungsten carbide core
Wa	See W, Wa	
WaA	Heeres-Waffenamt	Army Ordnance Office
Wabo	Wasserbombe	Depth charge or bomb (lit Water bomb)
WaF	Forschungsabteilung des Heereswaffenamts	Research Section of Army Ordnance Office (See also under Warplants, etc)
Wag	Wagen	Wagon; vehicle
WaPrüf	See under Warplants (descriptive section)	
W A S A -G; WASAG	Westfälisch-Anhaltische Aktiengesellschaft	Westphalian-Anhalt Stock Company
WC (such as in NC 50 WC)	———————— (50 kg Nebelcylindrische Bombe WC)	Marking on a 50 kg cylindrical smoke bomb (TM 9-1985-2, pp 58-9)
WEM	Waffenentgiftungsmittel	Liquid preparation for decontamination of weapons
Werf	See W; Werf	
Wfgr	Werfergranate	Mortar shell; rocket
Wfk; WK; WrfK	Wurfkörper	Special projectile for signal pistol such as Véry pistol

Example: WK 361 LP (Wurfkörper 361 fur Leuchtpistole) HE grenade (egg shape with stem) used for 26 mm signal pistol

Note: Abbreviation Wfk was used also to designate some rockets, such as 32 cm Wfk MF150, 28 cm WfkSpr and 30 cm WkSpr 42 (TM 9-1985-2, pp 251-254)

Wgr; WGr	Wurfgranate	Mortar shell; rocket
Wgr Grünr	Wurfgranate, Grünring	Chemical rocket, such as 150 mm pattern 41, with green ring
Wgr Nb	Wurfgranate Nebel	Mortar smoke shell; smoke rocket, such as 150 mm
WgrPatr LP	Wurfgranate Patrone für Leuchtpistole	HE mortar round for signal pistol

Examples: 2.6 cm WgrPatr 326LP (26 mm HE round with percussion fuze, for signal pistol) and 2.6 cm WgrPatr LPmZZ (26 mm HE round with time fuze, for signal pistol)

WgrSpr	Wurfgranate Sprenggranate	HE mortar shell or HE rocket

Example: 15 cm Wgr 41 Spr (150 mm HE rocket, spin stabilized and 21 cm Wgr 42 Spr (210 mm HE spin stabilized rocket) (TM 9-1985-2, pp 245 and 249)

WgrZ; WZ	Wurfgranatenzünder	Mortar shell fuze

Note: According to TM 9-1985-3 (1953), p 545 the WgrZ is a fuze for infantry gun or howitzer

WgrZT	Wurfgranatenzünder, Trolitul	Mortar shell fuze with body made of polystyrene plastic material
WH	Wehrmacht-Heer	Armed Forces Army (marking on vehicles)
WIFO	See under Warplants (descriptive section)	
Wimp	Wimpel	Pennant; streamer
WiSp	Winkelspiegel	Protectoscope (Tk); periscope
WK	See Wfk; WK; WrfK	
wKh (white stencilling)	weite Kammerhülse	Wide central flash tube (burster)
wKhNb	weite Kammerhülse, Nebel	Mortar smoke shell with solid filling and wide central flash tube
WL	Wehrmacht-Luftwaffe	Armed Force, Air Corps marking on vehicles
WL	See Wurfldg	
Wm	See W; Wehrm	
WM	Wehrmacht-Marine	Armed Forces, Navy (marking on vehicles)
WMZ	Wurfminenzünder	Mortar shell fuze
Wn	Wiener-Neustadt	Designation of airplanes built by Wiener Neustädter Flugzeugwerke, Austria
WO	Waffenoffizier	Ordnance officer
WP	Wachposten	Sentry post
WP	Würfelpulver	Flaked propellant (in small rectangular tablets); dice shaped propellant

WPC/88	Würfelpulver, Construktion 88	Flaked propellant, type 1888 (First German military smokeless propellant)
Wrf	See W, Werf	
Wsm (in rocket 8.6 cm RSpr 400 Wsm)	Weissman (8.6 cm Raketen Sprang 400, Weissman)	Name of designer (86 mm HE rocket 400, Weissmann)
WTP	Westentaschenpistole	Vest pocket pistol
Wu (such as in 21 cm BdStz DO-Wu)	———	Meaning unknown to us
Wurfldg; WL [such as in 10.5 cm Stgr 34S m Wurfldg (f)]	Wurfladung [10.5 cm Stahlgranate 34S mit Wurfladung (f)]	Reduced propelling charge [105 mm Steel Shell 34S with reduced propelling charge (French)]
WVA	See under Waplaeta (descriptive section)	
WW	Waffenwerkstatt	Weapon repair shop
WZ; WgrZ	Wurfgranatzünder	Mortar shell fuze
WZ-36; WgrZ-36	Wurfgranatzünder 36	Mortar shell fuze (TM 9-1985-3, p 404)
Wzg; WZg	Werkzeug	Tool; implement
WZgPatr	See Werkzeugpatrone in the Vocabulary	

Z

Z	Zeichnung	Drawing; blueprint; design
Z; Zt	Zeit	Time
Z; Zerst	Zerstörer	Destroyer (Navy)
Z; Zlg	Zerlegung	Self-destruction
Z	Ziel	Target; objective
Z	Zoll	Inch; custom duty
Z; Zg	Zug	Trail; pull; groove (rifling)
Z	Zugkraftwagen	Prime mover truck, tractor
Z; Zd; Zdr	Zünder	Fuze; igniter
Z; Zus	See Zus; Z	
Za; ZgA; ZA	Zeugamt	See in Vocabulary
ZaC; ZgAC	Zeugamt, Cassel	Ordnance Department, Cassel
ZaS; ZgAS	Zeugamt, Spandau	Ordnance Department, Spandau
zB	zum Beispiel	for example
ZB (black stencilling)	Zwischenbodengeschoss	Diaphragm shell; large caliber shell provided with a solid partition
ZC (B)	Concentcylindrische (Bombe)	Concen-cylindrical (bomb)
Examples: ZC 10, ZC 50 and ZC 250 (Concrete practice bombs described in TM 9-1985-2, pp 63-65)		
Zd	See Z; Zd; Zdr	
Zdg	Zündung	Firing; detonation; priming
Zdh; Zdhr	Zündhütchen	See in Vocabulary
Zdlg; ZdL; ZL	Zündladung	Booster charge (lit ignition charge); auxiliary booster
Zdlg A; Zdlg B; Zdlg C/98; Zdlg C/98 Np; Zdlg 36 Np	See under Booster in the descriptive part	
ZdldgB; ZLdgB	Zündladungsbüchse	Booster bushing
Zdmitt	Zündmittel	Priming or igniting substance
Zdr	See Z; Zd; Zdr	
Zdschn	Zündschnur	Safety fuse (lit Igniting string)
ZdschnANZ	Zündschnuranzünder	Igniter for safety fuse
ZdschnANZ-39	Zündschnuranzünder-39	Friction, pull type igniter pattern 39 used for the ignition of safety fuse in demolition work and for setting off some improvised mines and booby trap. (TM 9-1985-2, p 285)
Zdschr; ZSr	Zündschraube	Threaded percussion primer
ZdschrFu	Zündschrauben Futter	Threaded bushing for percussion primer
ZdSt	Zünderstreuung	Dispersion caused by fuze differences
ZdV	Zündverbindung	Relay (Fz)
ZDZ-29; ZuDZ-29	Zug- und Druck Zünder-29	Pull and pressure type igniter, pattern 29, for use in A/T and A/P land mines (TM 9-1985-2, p 292)
Zehnlg (such as (15 cm NbW Zehnlg 42)	Zehnling (15 cm Nebelwerfer Zehnling 42)	Ten-tuber (150 mm Ten-barreled smoke rocket launcher)
Zellst	Zellstoff	Cellulose
ZentrW	Zentrierwulst	Bourrelet (Proj)
Zerl	Zerleger	Self-destruction element (Fz)
ZerlFg	Zerleger, Fliehgewichts	Centrifugally operated self-destruction element in fuze

ZerlP; ZerlPv	Zerleger, Pulver	Black powder burning self-destruction element in fuze
ZerlPS; ZlPS	Zerleger, Pulversatz	Same as above
ZerlZ	Zerlegungszünder	Self-destroying fuze
zerspr	zersprengt	dispersed; scattered; blown up
Zerst	Zerstäuber	Spraying apparatus (CWS); sprayer; diffuser
Zerst	See Z; Zerst	
Zerst	Zerstörung	Demolition; destruction
Zertr	Zertrümmerung	Demolition; destruction
ZF	Zielfernrohr	Telescopic sight (arms)
Zf	Ziffer	Cipher; numeral
zF	zu Fuss	afoot; on foot
ZF-4	Zielfernrohr 4-fach	Rifle sighting telescope, 4-power
ZF	Zwischenfrequenz	Intermediate frequency (Rad)
Zf; ZF (such as in Zf Hbgr)	(Zünder für Haubegranate)	Marking on a point detonating fuze located under ballistic cap
Zg	See Z; Zg	
ZgA	See ZA; Za	
ZgHs	Zeughaus	Arsenal; armory
ZielF	Zielfernrohr	Telescopic sight
Zielgew	Zielgewehr	Subcaliber rifle (lit Target rifle)
Zielmun	Zielmunition	Subcaliber ammunition (lit Target ammunition)
Zit	Zitadelle	Citadel
Zk	Zündkerze	Spark plug
Zkw	Zugkraftwagen	Prime mover truck, tractor
Zl	Zinklegierung	Zinc alloy
ZL; ZdL	Zündlunte	Slow match; igniting cord; fuze igniter
ZL	Zwischenladung	Intermediate blasting charge (combat engineers)
ZLdg	See Zdldg; ZLdg	
ZlPS	See ZerlPS	
ZM	Zugmaschine	Prime mover, tractor
ZmV	Zünder mit Verzögerung	Delay-action fuze
Zn (marking on equipment)	Zink	Made of zinc
Zldg	See ZusLdg	
ZSaZ	See ZdschnANZ	
ZSprLdg	See ZusSprLdg	
ZSr	See Zdschr	
ZSrF fH lelT	Zündschraubenfutter für die Hülse der leichten Haubitze-in-Turm	Bushing for threaded percussion primer for cartridge of light tower howitzer
ZStM	Zünderstellmaschine	Automatic fuze setter (AA Arty)
Zt	Zeit	Time; period
Ztschr	Zeitschrift	Periodical publication
ZtZ; ZZdr; ZZ	Zeitzünder	Time fuze (TiFz)
ZtZdschn	Zeitzündschnur	Time safety fuze
ZuDZ; ZDz	See ZDZ	
Zus; Zu; Z	Zusatz	Addition; extension
ZusKart	Zusatzkartusche	Secondary propellent charge (in separate loaded ammo)
ZusLdg	Zusatzladung	Supplementary charge increment
ZusSprLdg	Zusatzsprengladung	Supplementary charge of HE
ZusZ 40	Zusatzzünder 40	Mechanical antiwithdrawal type fuze, pattern 40 (TM 9-1985-2, pp 177-8)
ZUW	Zünderuhrwerk	Clock mechanism fuze
ZuZZ-35	Zug- und Zerschneidezünder-35	Pull and tension wire release igniter used with S-Mine, some prepared charges and booby traps (TM 9-1985-2, p 290)
ZV	Zündervorrichtung	Austrian name for fuze
ZVer	Zeugverwaltung	Ordnance department administration
Zw; Zwill	Zwilling	See in Vocabulary
ZWB	See under Warplants (descriptive section)	
ZwL	Zwillingslafette	See Zwillingsgestell in Vocabulary
ZwMG; ZwillMG	Zwillingsmaschinengewehr	See in Vocabulary
ZwSk 42; ZwillSk 42	Zwillingssockel 42	Twin gun swivel (pedestal) pattern 42
ZwitFz	Zwitterfahrzeug	Half-track vehicle
Zyl	Zylinder	Cylinder
ZylP	Zylinderpulver	Propellant in cylindrical grains
ZylVerschl	Zylinderverschluss	Cylinder locking; bolt action
ZZ	See ZtZ; ZZdr	
ZZ (such as ZZ 1505)	Zerlegungszünder 1505	Self-destroying fuze, pattern 1505

ZZ	Zugzünder	Pull type igniter

Examples: ZZ-35 (pull type igniter used with trip wires in operating various mines) and ZZ-42 (pull or pressure type igniter used in booby traps and mock mines) (TM 9-1985-2, pp. 289 & 293)

zZ	zur Zeit	at the moment; at this time
ZZä, ZZü	Zünderzwischenstück	Fuse extension cup
ZylP	Zylinderpulver	Cylindrical powder
Ø	Durchmesser	Diameter

Abbreviations, References: See at the end of the previous section "Vocabulary of German Ordnance, Ammunition and Related Terms".